ESD-TR-70-32

DESCRIPTION OF COMPUTER PROGRAMS FOR THE ANALYSIS AND PRESENTATION OF TRADE WINDS DATA

Jerald Schwarz

December 1969

AEROSPACE INSTRUMENTATION PROGRAM OFFICE
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts 01730

(Prepared under Contract No. F19628-68-C-0208 by Syracuse University Research Corporation, Merrill Lane, University Heights, Syracuse, New York 13210.)

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FOREWORD

This report is prepared for the

Aerospace Instrumentation Program Office
Electronic Systems Division
Air Force Systems Command of the United States Air Force
L. G. Hanscom Field
Bedford, Massachusetts

Air Force Program Monitor - Lt. C. Schafer, ESD/ESSIE

Project Number 6684, Task 6684.08

covering research over the period

1969 March 1 to 1969 December 15.

Prepared under Contract No. F19628-69-C-0208 by

Syracuse University Research Corporation
Merrill Lane, University Heights
Syracuse, New York.

This report was reviewed and approved.

C. Schafer, Lieutenant, USAF
Program Manager for ESD/ESSIE/6684.

ABSTRACT

An investigation of the Trade Wind Duct was carried out from 6 March through 25 March 1969 in the Northern part of the Caribbean Sea. An instrumented aircraft was used to record meteorological and radio refractivity data in digitized format for computer analysis. In addition, extensive radiosonde data was included in the analysis to support the aircraft measurements and provide a basis for weather analysis. In order to assimilate, process and present such a large amount of data it was imperative that machine processing be used. The following report describes the various programs which were used in the analysis and presentation of the data. A ray-tracing program was also developed to analyze radio wave propagation in relation to Trade Wind Duct characteristics. This program has the advantage that horizontal changes in the Duct can be included. Most ray-tracing programs assume that the vertical variation of refractivity is spherically stratified.

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SECTION I

INTRODUCTION

This report describes the computer programs that were used in processing the data collected for this contract.

A brief summary of this processing is as follows:

PAPTOMAG:	Converts aircraft paper tape to magnetic tape.
QUACK:	Pre-processes radiosonde data.
RAWCON:	Processes output of PAPTOMAG. Converts this to atmospheric profiles.
PLOT:	Plots atmospheric profiles. Use output of QUACK RAWCON.
TRACE:	Performs ray-tracing and produces plots.

All the above except PAPTOMAG are written primarily in FORTRAN IV and run on an IBM 7094. PAPTOMAG is written in assembly language for an SDS-930. QUACK and RAWCON contain small input and utility routines written in assembly language. PLOT and TRACE make use of assembly language routines to produce plotting tapes for a Stromberg-Carlson 4020.

PAPTOMAG, PLOT, and TRACE were written specifically for this project. RAWCON is a modification of a program originally written at MITRE Corporation for an IBM 7030. QUACK was supplied by the sponsor.

SECTION II

PAPTOMAG

This program converts the paper tape containing the airplane measurements to 7-track magnetic tape. It is written in assembly language for an SDS-930 equipped with a paper tape reader and tape drive on the W buffer. The program takes three 8-bit characters from the paper tape and writes them as four 6-bit characters on the tape. The end of the paper tape roll is indicated by five consecutive blank frames. Records on magnetic tape are 1524 characters long. (The last record of a roll may be short.)

The program is organized to put multiple rolls of paper tape on a single magnetic tape. The paper tapes are organized as missions. Several rolls may make up a mission. The missions may be put on the proper tape in any order, but all rolls from a single mission must be put on together and in order. The output tape is on Unit 1.

At various times in the processing, the program will type messages and wait for a response. The only valid responses are Y or N followed by a carriage return. If any other response is given the program will request the response be re-entered.

The following are the messages and appropriate responses.

IS THIS A NEW MAG TAPE.

This message is always typed at the beginning of each program.

Responses:

Y — The program should start at the beginning of the magnetic tape.

N — Missions have been put on the magnetic tape previously. The program will skip to the end of the last mission already on the magnetic tape.

ARE THERE MORE ROLLS FOR THIS MISSION.

ARE THERE MORE MISSIONS FOR THIS MAGNETIC TAPE.

ARE THERE MORE MAGNETIC TAPES.

END OF MAGNETIC TAPE. RESTART LAST MISSION.

No response is needed to this message. Since all rolls of a single mission must be on the same tape, this message is typed when an end of magnetic tape is found. The operator should restart the first roll of the mission currently being converted after readying a new tape 1.

The program will print what is being put on magnetic tape unless sense switch 2 is set. For normal processing, therefore, this sense switch should be set.

Since no identification appears on the tape, it is very important that an accurate record be kept of which paper tapes have been converted.

In case of trouble, the following is relevant for repositioning. There is 1 EOF between each roll of a mission; 2 EOFs between each mission; 3 EOFs at the end of a tape.

SECTION III

QUACK

The purpose of the program "QUACK" is to read and find tropospheric ducts from the B4 hydro tapes, obtained from the Environmental Tactical Air Command (ETAC), located at the Washington Naval Yard. These tapes contain worldwide radiosonde and pilot balloon soundings and aircraft information.

The decks and relative location in the program "QUACK" and a short explanation of their purpose are as follows:

A.	WORK	Reads the B4 hydro tape and converts the data into a useable form. It also compiles statistical information concerning the soundings for all stations for each month.
B.	QT	Calculates the characteristics of tropospheric ducts. If a duct exists the program outputs the location, time, height, thickness, and refractivity gradient of the duct.
C.	HGT	Given two readings of pressure, temperature, and dew point, calculates the height difference between these levels.
D.	INDX	Given the pressure, temperature, and dew point, calculates the refractivity.
E.	DECOD	Unpacks each word of an array into six words each containing one character.
F.	HELP	Reads a variable length record until it finds a record mark or until it reads a maximum of 315 words. It counts the number of words read and flags it. Finds an end of file.
G.	PR	Flags appropriate counters when examining the pressure levels of a sounding for a given station. The counters are for first pressure LT 850, mandatory levels only, mandatory and significant levels, and mandatory levels and surface pressure.

3.1 Input

The program uses units B(1) and B(2) for input tape units. The program initially uses unit B(1), and if the operator desires to use another input tape, through proper use of the sense switches, the program will then use unit B(2). If other input tapes are desired, the program then transfers between unit B(1) and B(2). The format of the input data (the B4 hydro tape) follows:

A. CONTENTS AND FORMAT OF UPPER AIR DATA ON B4 HYDRO TAPE

(1) UNCLASSIFIED

(2) BCD MODE

(3) 800 BPI DENSITY, IN UNPACKED FORM

(4) BLOCKED ONE REPORT PER PHYSICAL RECORD. LOGICAL RECORDS CONSIST OF 20 DATA WORDS PLUS A 606060606072 WORD, PSEUDO RECORD MARK

(5) ALL NUMERIC WORDS ARE RIGHT ADJUSTED WITH LEAD BLANKS

(6) THE WORD "PIBAL" REFERS TO ANY REPORT CONTAINING ONLY WIND INFORMATION

(7) DATA ALTERED DURING CHECKING ARE FLAGGED ACCORDINGLY.

(A) RAOB HEIGHTS OR TEMPERATURES (FLAG LEFT ADJUSTED)

R = RECOMPUTED DATA

E = EXTRAPOLATED DATA

(B) WINDS, WHEN INCONSISTENT, ARE REMOVED AND A "D" REPLACES THE DIRECTION (RIGHT ADJUSTED).

(8) ALL DATA IN ALPHA-NUMERIC FORMAT

B. TIME RECORD CONTAINS FOUR WORDS AND IS THE FIRST RECORD ON THE TAPE.

(1) HOUR - BASIC DATA TIME

(2) DAY - DAY OF MONTH

(3) MONTH - NUMERICAL VALUE (1 JAN)

(4) YEAR - LAST TWO DIGITS (66 = 1966)

NOTE. A "$" INDICATES A BLANK CHARACTER

C. IDENTIFICATION. IN EACH RECORD, EXCEPT TIME RECORD, THE FIRST 8 DATA WORDS ARE USED TO IDENTIFY THE REPORT BY TYPE, TIME, AND LOCATION.

(1) TYPE OF REPORT - RAOB$$, PIBAL$$, AGFT$$

(2) BLOCK AND STATION

(A) 00000 IF ROVING SHIP

(B) NAME IF PERMANENT SHIP (4YA)

(C) IIIII FOR LAND STATION

(D) 00000 AIRCRAFT WITH NON-SPOT WIND, 77 AIRCRAFT WITH SPOT WIND.

(3) TIME - HOUR

(4) DAY - DAY OF MONTH

(5) MONTH - NUMERICAL (1 JAN)

(6) LATITUDE - IN HUNDREDTHS OF DEGREES (NO DECIMAL POINT)

(7) LONGITUDE - IN HUNDREDTHS OF DEGREES (NO DECIMAL POINT)

(8) ELEVATION - WHOLE METERS (0 FOR ROVING SHIPS AND AIRCRAFT)

D. DATA FORMAT

(1) RAOBS - 6 WORDS DESCRIBE EACH POINT OF A SOUNDING. ALL POINTS (SIG AND MANDATORY) ARE IN LOGICAL DESCENDING PRESSURE ORDER. THE SIX WORD FORMAT IS REPEATED AS MANY TIMES AS NEEDED FOR THE COMPLETE REPORT.

(A) PRESSURE - WHOLE NUMBERS

(B) HEIGHT - TENS OF FEET (0 IS SIG POINT)

(C) TEMPERATURE - SIGNED TO TENTHS OF DEGREE WITH DECIMAL POINT

(D) DEW POINT - SIGNED TO TENTHS OF DEGREE WITH DECIMAL POINT

(E) WIND DIRECTION - TO TENS OF DEGREE (0 IS SIG POINT)

(F) WIND SPEED - TO WHOLE KNOTS (0 IS SIG POINT)

(G) AFTER THE LAST POINT OF THE RAOB COMES THE TROP INFORMATION IN A FOUR WORD FORMAT

((1)) TROP $$ - IDENTIFIER

((2)) TROP PRESSURE - WHOLE MB'S

((3)) TROP HEIGHT - TENS OF FEET

((4)) TROP TEMPERATURE - TENTHS OF DEGREE WITH DECIMAL POINT

(H) NEXT IS SF (PRESSURE IN A TWO WORD FORMAT).

((1)) SPRESR - IDENTIFIER

((2)) SFC PRESSURE - WHOLE MB'S

(I) AND LAST IS MAXIMUM WIND INFORMATION IN A FOUR WORD FORMAT. (ONLY WINDS AT OR BELOW 44000 FEET ARE CONSIDERED.)

((1)) MAXWIND - IDENTIFIER

((2)) HEIGHT - TENS OF FEET

((3)) WIND DIRECTION - TO TENS OF DEGREE

((4)) WIND SPEED - TO WHOLE KNOTS

(J) WORDS 2, 3, AND 4 WILL BE 0 (ZERO) IF NO WINDS BELOW 44000.

(2) PIBALS. NEXT 26 WORDS FOLLOWING I.D. INFORMATION ARE WINDS FOR THE 13 STANDARD LEVELS (1000, 850, 700, 500, 300, 250, 200, 150, 100, 050, 030, 010) TWO WORDS PER LEVEL.

(A) WIND DIRECTION - TENS OF DEGREES

(B) WIND SPEED - WHOLE KNOTS

AFTER THE STANDARD LEVEL WINDS ARE THE WORDS $TOTAL $PIBAL. FOLLOWING THIS IS A COMPLETE LIST OF ALL THE PIBAL WINDS IN A TWO WORD FORMAT REPEATED AS MANY TIMES AS NEEDED FOR THE COMPLETE RUN.

(A) HEIGHT - IN THOUSANDS OF FEET

(B) WIND - DIRECTION AND SPEED (DDFF)

((1)) LEFT 3 CHARACTERS - WIND DIRECTION IN TENS OF DEGREES

((2)) RIGHT 3 CHARACTERS - SPEED IN WHOLE KNOTS

(3) ACFT. WORDS AFTER I.D. AS FOLLOWS:

(A) PRESSURE LEVEL - WHOLE MB'S

(B) HEIGHT OF STANDARD LEVEL - TENS OF FEET (FROM RECCO ONLY)

(C) TEMPERATURE - TO TENTHS OF DEGREE WITH DECIMAL POINT (FROM RECCO ONLY)

(D) WIND DIRECTION - TENS OF DEGREES

(E) WIND SPEED - KNOTS

(F) TRUE ALTITUDE - HUNDREDS OF FEET

(G) ICING - $000RT

R = RATE OF ICING

T = TYPE OF ICING

(H) FLIGHT CONDITION AND TURBULENCE - $OWFCBK

W = WEATHER

F = FLIGHT CONDITION

B = TURBULENCE INTENSITY

K = CHARACTER OF TURBULENCE

PARAMETER REPORTED IN WORDS SEVEN AND EIGHT ARE CONVERTED TO RECCO CODE UNITS WITH EXCEPTION W - 3 DENOTES BROKEN CLOUD COVER

(I) CLOUDS (LOWEST LAYER REPORTED $NBBTT)

N = AMOUNT OF CLOUDS

BB = BASES

TT = TOPS

WORDS 10, 11, AND 12 (SAME FORMAT AS 9) WILL BE USED AS NEEDED TO DESCRIBE MULTIPLE LAYERS.

IF 5 OR MORE LAYERS ARE REPORTED WORD 12 WILL BE THE HIGHEST LEVEL REPORTED. IN WORD 7 THROUGH 12 THE "=" SYMBOL WILL DENOTE A MISSING ELEMENT.

E. SEQUENCE OF REPORTS

(1) ROVING SHIPS (BLOCK AND STATION = 0) BY LATITUDE AND LONGITUDE.

(2) PERMANENT SHIPS BY NAME (4YA, 4YB, ETC.)

(3) LAND STATION BY BLOCK AND STATION NUMBER. WHEN A STATION HAS BOTH A RAOB AND PIBAL THE RAOB PRECEDES THE PIBAL.

(4) AIRCRAFT REPORTS BY LATITUDE AND LONGITUDE.

3.2 Output

There are several outputs produced by QUACK. Only one of them was used in this project.

For each launch processed, three logical binary records are produced on FORTRAN UNIT 11.

RECORD 1. Nine (six-character) words.

Words 1 - 7 are station number, latitude, longitude, station elevation, launch hour, launch day, and launch month. The words are BCD right adjusted with leading blanks. Words 8 - 9 are binary integers which describe the second record.

RECORD 2. 2000 words.

This record contains a 4 x 500 floating point array: each row of four numbers contains temperature (° C), dew point (° C), height (m), refractivity (M units).

Word 8 of record 1 is the row number of the first row of the array containing valid information. Word 9 of record 1 is the row number of the last row of the array containing valid information.

RECORD 3 is not relevant.

SECTION IV

RAWCON

The index of refraction at a point in the atmosphere may be obtained directly by taking a refractometer reading at that point, or it may be computed indirectly from the temperature, pressure, and humidity values.

The primary function of the program RAWCON is to accept refractometer and atmospheric data from airborne observations and to compute the refractivity from this information. The principal output is then the refractivity as a function of the altitude. The program also produces such output as potential temperature, potential index, vapor pressure, and mixing ratio. It produces both a printed listing and secondary output which can be used for further processing.

The program provides the user with the choice of computing refractivity by either the direct or the indirect method. An option for producing output on punched cards is also provided. The program accepts atmospheric input data through magnetic tape. Any information punched onto paper tape must be converted to magnetic tape before it can be used by RAWCON.

This program is based entirely on a program written at MITRE Corporation. This program is described in MITRE working paper 919[1]. This description is largely a reproduction of this working paper. Sections which have not been changed are indicated by an * after the section title.

4.1 Computations

4.1.1 Basic Computations*

Rather than computing the index of refraction, n, this program will deal with the refractivity, N, which is defined by

$$N = (n - 1)\, 10^6$$

---

1. Beebe, Otto W., "REFCOL, A Data Reduction Program for the Generation of Refractivity Profiles," Mitre Corporation WP919, 9 November 1966.

The relation between the refractivity, N, and the various atmospheric parameters is given by

$$N = 77.6 \frac{P}{T} + 3.73 \times 10^5 \frac{e}{T^2} \qquad (1)$$

where T = Temperature in $^\circ$ K.

P = Pressure in millibars.

e = Partial pressure of water vapor in millibars.

Suppose that, for the "direct" refractometer calculation, the variation of frequency with respect to refractivity is 9.245 kc/N. Suppose further that:

h_o = Initial height.

F_s = Reference frequency at h_o.

N_s = Reference refractivity corresponding to F_s.

F = Frequency observed at height h.

Then the difference in refractivity (ΔN) between height h_o and height h is given by

$$\Delta N = \frac{F - F_s}{9.245}$$

Refractivity at height h is then:

$$N = N_S - \Delta N \qquad (2)$$

From (1) and (2) the vapor pressure e can be computed by

$$e = \frac{T^2 \left(N - 77.6 \frac{P}{T}\right)}{3.73 \times 10^5}$$

The mixing ratio, r, is defined by

$$r = \frac{.62197e}{P - e}$$

The geopotential height (Z) is computed by the following formulas:

$$\begin{cases} Z_1 = h_0 \\ Z_{k+1} = Z_{k+1} \\ \Delta Z_{k+1} = \dfrac{\mu_{k+1} R}{A} \left(1 + \dfrac{2Z_k}{R} + \dfrac{\mu_{k+1}}{A}\right) \\ \mu_{k+1} = 14.645 \left[T_k \left(1 + 0.388 \dfrac{e_k}{P_k}\right) + T_{k+1} \left(1 + 0.388 \dfrac{e_{k+1}}{P_{k+1}}\right)\right] \ln \left(\dfrac{P_k}{P_{k+1}}\right) \\ \qquad \text{for } k = 1, 2, 3, \ldots\ldots \end{cases}$$

where h_0 = Beginning height.

P_k = Pressure (mb) for k'th reading.

T_k = Temperature (° K) for k'th reading.

e_k = Vapor pressure (mb) for k'th reading.

A = Length of semi-major axis (km).

R = Length of semi-minor axis (km).

The potential temperature, T_P, is given by:

$$T_P = T \left(\frac{1000}{P}\right)^{2/7} - 273.16$$

The potential index K is given by:

$$K = N \left(\frac{1000}{P}\right)^{0.714}$$

4.1.2 Input and Corrections*

All parameters which are received from magnetic tape are converted by the input routines into a four digit floating point representation. In order to be of use in the computations, further scaling and corrections must be performed.

The following parameters are received as input from magnetic tape:

1. Time
2. Frequency (Kc, Refractometer No. 1).
3. Frequency (Kc, Refractometer No. 2).
4. Frequency (Kc, Refractometer No. 3).
5. Altitude (radar interval counter).
6. Event.
7. Air Speed.
8. Pressure.
9. KS4 Temperature.
10. EK Temperature.
11. Humidity.
12. Voltage (Refractometer No. 4).
13. Vortex Temperature.

The temperature, air speed and pressure values are in a linear relation with their final floating point representation and are converted by a linear function (TLIN). The user establishes the conversion functions which are to be employed. The user also specifies correction constants for these parameters.

The program applies a further correction to the value of the selected temperature probe. Suppose T_S is the value of the selected probe, then

$$T = (T_S + 273.16)/(1 + B_k S)$$

where

$$k = \begin{cases} 1, \text{ if KS4 probe} \\ 2, \text{ if EK probe} \\ 3, \text{ if Vortex probe} \end{cases}$$

β_k is an input parameter = speed corrections for temperature probes

$$S = \frac{SPEED^2}{P}$$

T = temperature in $^\circ$ K and will be used in all computations involving temperature.

The following corrections are made to the refractivity computations:

$$\Delta N = \frac{F - F_S}{9.245} + \alpha \left[T (1 + \beta_4 S) - T_0 \right]$$

α = Temperature correction for cavity expressed in N units/° C. (This correction varies from time to time.)

where α, β_4 are correction constants supplied by user.

T_0 = Surface temperature in ° K.

The "uncorrected" value for refractivity is then given by:

$$N = N_S - \Delta N$$

The "wet" term of N is computed by:

$$N_{WET} = C_2 \quad N \frac{C_2}{C_1} - \frac{77.6P}{T}$$

where $C_1 = 1 + 3.5 \beta_5 S$ (β_5 supplied by user.)

$C_2 = 1 + \beta_5 S$

The vapor pressure e is then:

$$e \frac{N_{WET} T^2}{3.73 \times 10^5}$$

and the final "corrected" value for refractivity is given by:

$$N^* = 77.6 \frac{P}{T} + N_{WET}$$

4.2 Magnetic Tape Format

The IBM 7094 has seven track tapes and a 36-bit word. The paper tape has 8-bit characters. The 8-bit characters are packed without any slack bits. Thus, nine characters are packed in two words. The magnetic tape contains no information except a representation of the paper tapes.

Within missions, paper tapes are separated by file marks. Missions are separated by double file marks, and the end of the tape is delineated by a triple file mark.

The tape is set up on IBSYS unit A(1).

The following table gives the legal 8-bit paper tape codes and their meaning. Any other codes which appear on the paper tape are considered errors.

Paper Tape (Octal Representation)	Meaning
001	1
002	2
023	3
004	4
025	5
026	6
007	7
010	8
031	9
040	0
200	End of Line

4.3 Control Card Parameters

Input to the program consists of groups of parameter cards separated by cards containing *END* in columns 1 - 5.

The program will process a part of the input tape according to the values of a large number of parameters. However, the program contains default settings for most of the parameters and once a parameter value is set it continues to have that value until explicitly changed. Thus, generally each group of cards need only contain values of flight parameters.

Succeeding groups of parameter cards must specify data in the same order as it is contained on the tape.

The format of the parameter cards is:

Column 1 - 6	The name of the parameter.
Column 9 - 18	The value of the parameter if the parameter is floating, integer, or a time.
Column 19 - 24	The value of the parameter if the parameter is alpha-numeric or logical.
Column 25 - 54	Comments

An integer value may be expressed either with a decimal point or else right adjusted to column 18.

A time parameter must be expressed as an integer HHMMSS (either with a decimal point or right adjusted to column 18) in which the first two digits are the hour, the next two the minute, and the last two the second.

A logical parameter must be punched as a "T" or "F" in column 19 with columns 20 - 24 blank.

If a card with "*STOP*" in columns 1 - 6 is encountered while reading parameter cards, the program terminates immediately.

The following is an example:

```
$DATA
PUNCH              T
RADIUS  6370999.
KPAR    0.
R       6339971.
A       6331158.
ITPROB  3.
IRSCT   2.
CHKFC              T
ZS      0.
ALPHA   0.                    V 6 FEB 3,1967
T4MIN   -10.
T4MAX   30.
T4VMIN  410.
T4VMAX  880.
EKMIN   -10.
EKMAX   30.
EKVMIN  100.
EKVMAX  650.
VXMIN   -10.
VXMAX   30.
VXVMIN  340.
VXVMAX  820.
PMIN    600.
PMAX    1050.
PVMIN   115.
PVMAX   970.
MISID              CAR001 MARCH 6,1969 KEY WEST
TSTART  063140.           MARCH 6,1969 KEYWEST
TSTOP   095000.           MISSION 1
ZOFS1   152.              MARCH 6,1969 KEYWEST
RNM1    355.              MARCH 6,1969 KEYWEST
RFS1    2710.             MARCH 6,1969 KEYWEST
RKP1    294.3             MARCH 6,1969 KEYWEST
CPRES   1.
*END*
MISID              CAR003 MARCH 9,1969
TSTART  103500.           MARCH 9,1969
TSTOP   154000.           MARCH 9,1969
ZOFS1   305.              MARCH 9,1969
RNM1    382.              MARCH 9,1969
RFS1    2511.             MARCH 9,1969
RKP1    296.8             CAR003
CPRES   2.
*END*
*STOP*
```

The following is a table of all Mission Parameters and the associated default settings:

Code	Type	Default	Description
RFS1	R	1871.0	Reference Frequency of Refractometer.
RFV1	R	0.0	Reference Voltage of Voltage Refractometer.
RNM1	R	316.0	Reference Refractivity.
RKP1	R	285.94	Surface Temperature in $^{\circ}$ K.
ANDF1	R	0.0	Refractivity of Dry Air at Surface.
ANWF1	R	0.0	Refractivity of Wet Air at Surface.
ACMRVP	R	0.0	Height (m) above which Mix-Ratio, Vapor Pressure, and Refractivity will be corrected.
CORMR	R	0.0	Correction to Mixing Ratio.
CORVP	R	0.0	Correction to Vapor Pressure.
CORIN	R	0.0	Correction to Refractivity.
ITPROB	I	1	Selection of Temperature Probe. If ITPROB = { 1, select KS4 probe. 2, select EK probe. 3, select Vortex probe.
IHUM	I	0	Selection Between Refractometer and Humidity Processing. If IHUM = { 0, process refractometer input. 1, do not process refractometer but process humidity input.
IRSCT	I	1	Selection of Refractometer. If IRSCT = { 1, use Refractometer No. 1 2, use Refractometer No. 2 3, use Refractometer No. 3 4, use Voltage Refractometer

Code	Type	Default	Description
PUNCH	L	.FALSE.	Option for output through Unit. If PUNCH = .FALSE., no output on Unit 1 .TRUE., no output on Unit 1
CHKFC	L	.TRUE.	Option to check input line length. If CHKFC = .TRUE., reject lines of incorrect length. .FALSE., do not check line length.
KPAR	I	1	Option to process a reading if a parity error is found. If KPAR = 0, do not process reading. 1, process readings with parity error[1].
BETA1	R	.0002632	β_1 correction for KS4 Temperature.
BETA2	R	-0.0002106	β_2 correction for EK Temperature.
BETA3	R	-0.0000648	β_3 correction for Vortex Temperature.
BETA4	R	0.0001316	β_4 correction for Refractometer.
BETA5	R	0.0000658	β_5 correction for Refractometer.
ALPHA	R	-0.75	α correction for ΔN.
RADIUS	R	6357000.	Radius of Earth.
R	R	6354120.	Length of Semi-Minor Axis.
A	R	6356363.	Length of Semi-Major Axis.
PROCS	L	.TRUE.	Selection to Process Data If PROCS = .TRUE., then process data .FALSE., do not process.
DUMP	L	.FALSE.	Selection to dump tape input. If DUMP = .TRUE., dump aircraft input. .FALSE., do not dump.
ZS	R	535.4117	Height of surface above Sea Level.

1. If readings with parity errors are processed, then on the printed output the reading number is followed by *.

The following parameters establish the linear conversion functions for Speed, Pressure, and Temperature input (tape).

Code	Type	Default	Description
PVMIN	R	18.	Minimum voltage of pressure probe (mv).
PVMAX	R	1017.	Maximum voltage of pressure probe (mv).
PMIN	R	600.	Pressure corresponding to PVMIN (mb).
PMAX	R	1060.	Pressure corresponding to PVMAX (mb).
SVMIN	R	691.	Minimum voltage of Air Speed probe (mv).
SVMAX	R	1060.	Maximum voltage of Air Speed probe (mv).
SMIN	R	135.	Air Speed corresponding to SVMIN (knots).
SMAX	R	195.	Air Speed corresponding to SVMAX (knots).
T4VMIN	R	190.	Minimum voltage of KS4 temperature probe.
T4VMAX	R	891.	Maximum voltage of KS4 temperature probe.
T4MIN	R	-40.	Temperature corresponding to T4VMIN.
T4MAX	R	35.9	Temperature corresponding to T4VMAX.
EKVMIN	R	278.	Minimum voltage of EK temperature probe.
EKVMAX	R	769.	Maximum voltage of EK temperature probe.
EKMIN	R	-40.	Temperature corresponding to EKVMIN.
EKMAX	R	35.9	Temperature corresponding to EKVMAX.
VXVMIN	R	241.	Minimum voltage of Vortex Temperature probe.
VXVMAX	R	1050.	Maximum voltage of Vortex temperature probe.
VXMIN	R	-40.	Temperature corresponding to VXVMIN.
VXMAX	R	32.	Temperature corresponding to VXVMAX.

The following flight parameters are those likely to change with each request.

Code	Type	Default	Description
MISID	A	None	Mission ID.
TSTART	T	0.	Flight Start Time.
TSTØP	T	235959.	Flight Stop Time.
CPRES	R	0.	Pressure Correction.
CSPEED	R	0.	Speed Correction.
CKS4T	R	0.	KS4 Temperature Correction.
CEKT	R	0.	EK Temperature Correction.
CVXT	R	0.	Vortex Temperature Correction.
ZØFS1	R	914.	Beginning Height.

In addition to these parameters the tape to be processed must be specified. This is done through various variables placed in labeled commons.

The following is a list of the tape-description parameters:

Common	Variable	Description
ZTPDNN	NMISS	Number of Missions on the Tape.
ZTPDNN	NAMES (I)	Name (Number) of the ith Physical Mission.
ZTPDNT	NTMPER (I)	Number of Time Periods in ith Mission. (New time period, if off-the-air for more than one hour.)
ZTPDHL	ISPEC (1,I) ISPEC (2,I)	Start Hour for ith Time Period (0-24). Stop Hour for ith Time Period.
ZTPDMP	MAPT (J)	The Position Number of the jth Input Parameter of a "Reading" where Time is input parameter No. 1, Refractometer 1 is input parameter No. 2, etc. The standard input sequence is the same as listed in section 2-2.
ZNFPL	NFPL	Number of parameters in a reading.

Every airborne "reading" consists of a maximum of 13 parameters. Due to frequent changes in the equipment configuration, these parameters may appear in a sequence other than the standard format. MAPT (j) allows the arbitrary ordering of input parameters on the mission tape, since it provides a mapping to the standard sequence.

4.4 Secondary Output

If parameter PUNCH is true, certain variables are output to FORTRAN Unit 1. There is one record for each "reading," and at the end of each flight a tape mark is written.

The record has the following format:

Column 1 - 6	Count which appears on listing.
Column 7 - 13	Height (in meters).
Column 14 - 20	Refractivity (N units).
Column 21 - 27	Refractivity (M units).
Column 28 - 34	Temperature ($^\circ$ C).
Column 35 - 41	Potential Temperature ($^\circ$ C)
Column 42 - 48	Water Vapor Pressure (mb).
Column 49 - 55	Air Pressure (mb).
Column 56 - 62	Mixing Ratio (g/Kg).

4.5 Restriction on Indirect Method for the Computation of Refractivity*

RAWCON provides two methods for the computation of refractivity. The "direct method" obtains the value of the refractivity directly from a refractometer, while the "indirect method" arrives at the result from various atmospheric parameters such as temperature, pressure and humidity.

The formula used in this case is again

$$N = 77.6 \frac{P}{T} + 3.73\ 10^5 \frac{e}{T^2}$$

where e must be obtained through the mixing ratio and a vapor pressure table (EH20).

Since the currently used humidity probe is functioning in an unreliable fashion, the humidity input has been set to a constant 100%. Thus, any refractivity results obtained by the "indirect method" are based on a humidity parameter of 100%. If, at any future time, it is desired to use the actual observed value for humidity, a minor modification must be made to the subroutine "WET."

4.6 Structure of RAWCON*

RAWCON is a collection of individual subroutines, with each subroutine serving an integral function. This collection of subprograms separates into two categories:

1. Reading and pre-processing of input.
2. Computation and output.

4.6.1 Input-Oriented Subroutines

INPUT	This routine controls "line" input. By a "line" of input we mean one complete set of instantaneous atmospheric readings consisting of time, temperature, pressure, ...
KHAR	This routine reads and interprets characters.
PINT1	This routine is the mission parameter card interpreter.
RDLINE	This routine reads a "line" of data.

4.6.2 Computation-Oriented Subroutines

REFCOL	This subroutine controls all computation-oriented routines and produces the output.
PAT	Routine to compute pressure, air-speed, and temperature.
WET	This routine computes refractivity, vapor-pressure and mixing ratio by the indirect method.
REFCT	This routine computes refractivity, vapor-pressure and mixing ratio by the direct method.
HEIGHT	This routine performs the geopotential height computations.

The only linkage between the input-oriented routines and the computational routines is in the driver-program AIDA with a call to RAWCON. The only data link between the two categories is a labelled COMMON with the name /INPT/.

SECTION V

PLOT

This program processes meteorological data and produces a plotting tape for the Stromberg-Carlson 4020. The source of the meteorological data is either a tape produced by RAWCON or a tape containing radiosonde data produced by RSONDE. Card input is also used to control what data is plotted.

For each set of readings specified by control cards two frames are produced. The first frame contains refractivity. Two lines are plotted, one in N units and one in M units. The second frame contains three lines 1) Temperature (labeled T); 2) Potential Temperature (labeled θ); 3) Vapor Pressure (labeled E). All these parameters are plotted horizontally with the vertical axis being height with limits of Om. and 4000 m.

5.1 Operational Procedure Under IBSYS

The tape to be processed must be "set up" as FORTRAN logic unit 1. There are two routines named "INPUT" in the deck. One is used for plotting RAWCON tapes, the other is used for plotting QUACK tapes. The subroutine for plotting RAWCON data has a deckname of "XINPUT", the one for the QUACK data has a deckname of "XINRAD". Either one of these must be removed or a $USE IBJOB control card may be used. The format of this card is either

```
1          16
$USE       XINPUT (INPUT)
$USE       XINRAD (INPUT)
```

The first is used for RAWCON data, the second for RSONDE data.

5.2 Plotting RAWCON Data

The output tape from RAWCON consists of a file for each set of parameters processed. Card input to PLOT consists of one card for each set of data to be plotted. The format of the card is:

Column	Contents
1 - 4	FILE
5 - 6	Number of the file (must be between 1 and 20 with a leading 0 if it is less than 10).
9 - 13	First reading to be plotted (right adjusted number).
14 - 18	Last reading to be plotted (right adjusted number).
20 - 49	Any characters; it is used as a title

The "reading" numbers referred to are the numbers printed in the column headed "READINGS" by RAWCON.

Successive cards must be increasing, i.e., either specify a higher file number or have a first reading number greater than the last reading on the previous card.

Processing is terminated by a card with *STOP* in columns 1 - 6.

5.3 Plotting QUACK Data

The output tape from QUACK is mounted on FORTRAN Unit 1. The program selects only certain stations and days for plotting. These are specified by input cards.

The stations are specified on a group of cards with the following format: 12 fields of 6 characters each. The first field contains the number of stations, succeeding fields contain the station numbers. All fields are right adjusted, blank filled. As many cards as required are read.

The days to be plotted are specified in a manner similar to the above. The first field contains the number of days and the succeeding fields contain the day numbers.

Plot Format

The plot format is controlled by various labeled commons. There are two BLOCK DATA programs included in the current deck to initialize these parameters. XBLK produces two frames for each profile, each frame being approximately 6" x 8". SMLBLK provides alternate values for some of the parameters which result in one frame for each profile with two plots on the frame, each plot approximately 3" x 4".

SECTION VI

TRACE

TRACE is a "ray tracing" program. It can be used to follow the propagation of radio waves through a changing atmosphere. The calculations are based on Snell's law and do not take into account diffraction, scattering, or interference.

Input to the program consists of atmospheric profiles, and control cards. The program will accept multiple profiles and interpolate between them. All profiles must be in the path of the ray being traced; no cross-path interpolation is performed. The on-path interpolation is not linear and the user (see *PROF card) has considerable influence over how it is done.

The control cards allow the user to trace groups of rays at various heights, ranges, and elevation angles. A ray is always reflected from the surface and the user may specify reflection from an elevated "level" as well.

Both printed output and a plotting tape (for a Stromberg-Carlson 4020) can be produced by the program. Printed output consists of a summary of control information, and (as an option) detailed descriptions of each ray's path.

6.1 Input Format

All control cards have the following format:

Column 1	*
Column 2 - 10	Function
Column 11 - 80	Seven parameters in fields of 10 columns. Parameter 1 in Column 11 - 20. Parameter 2 in Column 21 - 30, etc.

"Function" is an alphabetic code to tell what kind of card this is. The parameters are numeric. They may appear anywhere in the appropriate field but a decimal point must be present, even for integer values (e.g., RAYCOUNT). Not all functions use all parameters. There are two other types of cards, the cards which describe the atmosphere (see *PROF card) and the title card (see *TRACE card). The following conventions hold for the units on control cards: Height is always expressed in meters, range in kilometers and elevation in radians. However, when the program prints a range without indicating the units, it is in meters.

Many control cards turn "options" on or off. All options are off at the start of processing and are only changed by control cards.

6.2 Control Cards

*PRINT

Parameters: None

Function: Turns on the printing option.

When this option is on, detailed descriptions of the path of each ray are printed.

*NOPRINT

Parameters: None

Function: Turns off the printing option.

When this option is off only summaries are printed for each ray.

*STOP

Parameters: None

Function: Terminates processing.

*PATH

Parameters: None

Function: Resets the program and prepares it to accept profiles for a new path.

It must appear before any *PROF cards.

*PROF

Parameters: RANGE

Function: Marks the beginning of a profile.

The cards immediately following it describe the atmosphere at the indicated RANGE. The range must be larger than the range of any previous profiles in the same path, (i.e., between *PATH cards the ranges must increase). When the program encounters this card it reads profile description cards until a *PEND card is read. A profile description card has the following format:

Column 1 - 6	Either blank or contains "*LEVEL"
Column 11 - 20	Height
Column 21 - 30	Refractivity in N units at that height.

Within a profile the heights on successive profile cards must be increasing, except that successive cards with identical height and refractivity are allowed. (This allows two levels to appear at the same height.) The profiles of any path may have varying numbers of profile description cards but must all have the same number of *LEVEL cards.

The *LEVEL cards are used to describe the interpolation. Basically, the program divides the atmosphere into blocks bounded in range by the range of the various profiles and in height by lines connecting corresponding levels. See the section on interpolation for a more detailed description.

The program always constructs a level for the first and last height of a profile; if these heights are specified with *LEVEL cards, there will be multiple levels at these heights. This situation will be properly treated by the program.

*PEND

Function: Terminates the reading of profile description cards.

*TRACE

Parameters: START-RANGE, START-HEIGHT, START-ELEVATION, STOP-RANGE, RAY-COUNT, BUMP-VARIABLE, DELTA

Function: Initiate tracing of rays.

The number of rays which this card causes to be traced is given by RAY-COUNT. (If RAY-COUNT is 0, one ray is traced.) The first ray has a start height, range and elevation as given by the first three parameters. The start conditions of the other rays are determined by BUMP-VARIABLE and DELTA. For each succeeding ray, DELTA is added to the start range, height, or elevation depending on whether BUMP-VARIABLE is 1, 2, or 3, respectively. Tracing continues with reflections from the surface (if the surface is included in the input profiles). A ray is stopped when its range exceeds STOP-RANGE or its height leaves the range in which the atmosphere is specified. The card immediately following the *TRACE card is a title card. Columns 1 - 30 of the title card are used as a title in various places of the output.

*PLOT

Parameters: START-RANGE, FRAME-RANGE, BOTTOM-HEIGHT, TOP-HEIGHT, DENSITY, GRID

Function: Turns on the plotting option.

No plotting occurs when it is read. Rather, when a *TRACE card is processed all rays traced will be plotted together. Rays from multiple *TRACE cards may be plotted together using *HOLD and *ENDHOLD cards. The parameters establish the scale and grid for the plots. If they are omitted, reasonable values are used. More than one frame may be used to plot a set of rays if the range of the rays require it. FRAME-RANGE is the range (in Km) covered by each frame. Rays are plotted only when their height is greater than BOTTOM-HEIGHT, and less than TOP-HEIGHT, and their range is greater than START-RANGE. GRID determines how tall the plots are. It must be between 0 and 950. The plots are taller when it is larger. DENSITY indirectly determines the number of grid lines. It must be between 8 and GRID. There are fewer grid lines when it is larger.

*NOPLOT

Parameters: None

Function: Turns off the plotting option.

*DELHT

Parameters: HEIGHT-INCREMENT

Function: Specifies a maximum height difference between succeeding points in the trace.

(Under various circumstances the difference will be less than HEIGHT-INCREMENT, but it will never be more.) This value holds for all succeeding traces until another *DELHT card is encountered. Before a *DELHT card is encountered the maximum difference is 20 meters. For a detailed description of how the next point is chosen in the iteration see the section "Step Size."

*REFLECT

Parameters: LEVEL, STOP-ATTENUATION, FREQ

Function: Turns on the reflection option.

Rays will be reflected from the level numbered LEVEL. (Note: Since the program automatically adds a level at the first input height the number of the first *LEVEL card is level 2.) At reflection, from the surface or the level, an attenuation is computed. When the strength of the ray falls below STOP-ATTENUATION tracing for that ray stops (STOP-ATTENUATION is given in dB. It may be given as positive or negative. Its absolute value is used.). FREQ is the frequency in MHz to be used in computing the attenuation. If either STOP-ATTENUATION or FREQ is omitted reasonable values are used.

*NOREFLECT

Parameters: None

Function: Turns off the reflection option.

*HOLD

Parameters: None

Function: Delimits start of rays to be collected.

Normally the rays of a single *TRACE card are plotted together. When a *HOLD card is encountered the plotting is suspended but all rays are accumulated.

*HOLDEND

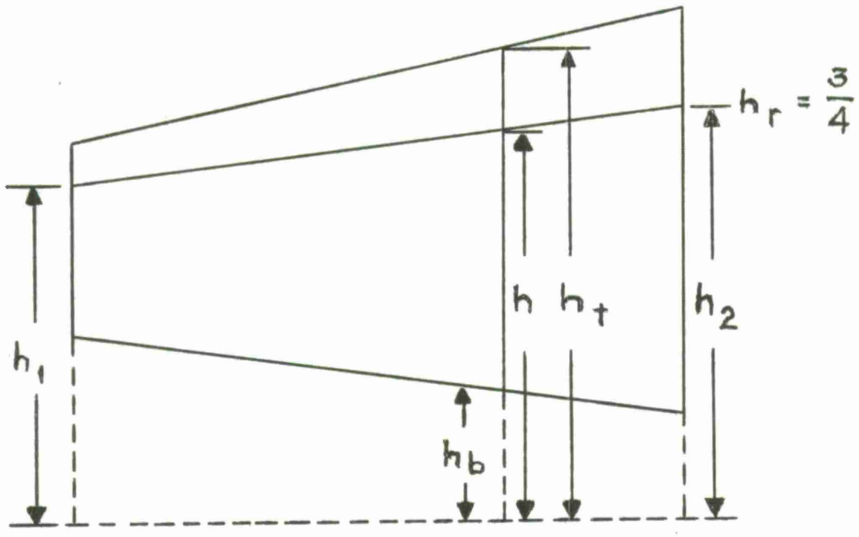
Parameters: None

Function: Delimits end of rays to be collected.

When this card is read all the rays which have been traced since the last *HOLD card are plotted together.

6.3 Interpolation

The interpolation algorithm was motivated by the following consideration: The atmosphere must be modeled in a manner which allows perturbations, such as a layer, to move up and down while the basic profile remains the same. As part of the input profile the user specifies heights which are to be used as levels. The program constructs blocks of the atmosphere bounded by the ranges of the profiles and lines connecting corresponding levels.



To determine the refractivity of an arbitrary point (H, r) the process is as follows:

1. Determine the block in which the point lies.

2. Calculate its "relative height" within the block $h_r = \frac{h - h_b}{h_t - h_b}$ where h_t, h_b are the heights of the top and bottom of the block, respectively, at range r.

3. Determine, at the ranges bounding the block, the refractivity at relative height, h_r. These heights are labeled h_1 and h_2 in the diagram. This is done by linear interpolation between points on the input profiles.

4. The refractivity is calculated by a linear interpolation along the line of relative height h_r, (i.e., the line connecting h_1 and h_2).

6.4 Step Size

The formulas used for each step of the ray are based on an integral over height. If the current height is h, the next height is determined in the following procedure.

1. Add to h either +DELHT or -DELHT depending on whether the ray is going up or down. Set h' to this height.

2. On the last iteration the "limits of linearity" were determined as a by-product of the calculation of refractivity. These limits are the heights, at the last range, between which the interpolation model (as described in Section 6.3) gives a linear atmosphere. If either of these heights is between h and h', set h' to it.

3. If the difference between h and h' is less than one meter, make it one meter.

4. If the ray path has a turning point between h and h', set h' to the height at which the elevation is 0 and change the direction of the ray. The final value of h' is the next height.

6.5 Equations

The formulas used in the iterative process are due to Colin Gardner. Their derivation, as summarized here, is contained in Pacific Missile Range, Technical Note 3280-6, "Determination of Elevation and Slant Range Errors due to Atmospheric Refraction."

The following is a summary of the derivations.

Notation.

B is the elevation angle.

θ is the earth central angle.

H is height.

N is refractive index.

We assume Snell's law for a spherical earth.

$$N_0 \left(1 + \frac{H_0}{r}\right) \cos B_0 = n \left(1 + \frac{H}{r}\right) \cos B = k$$

Then

$$d\theta = \frac{MQ}{r + H} = \frac{\cot B \, dH}{r + H} = \left(1 + \frac{H}{r}\right) \sqrt{n^2 \left(1 + \frac{H}{r}\right)^2 - k^2}$$

assuming that $\frac{dN}{dH} = a$ is constant

$$ndH = \left[\frac{n}{a (r + H) + n} \right] \frac{rk \sin B}{\cos^2 B} \, dB$$

Thus

$$d\theta = \frac{n}{a (r + H) + n} \frac{rk \sin B}{\cos^2 B} \, dB$$

or

$$\Delta\theta = \int_{B_r}^{B_{r+1}} \frac{n}{a (r + H) \, rn} \, dB$$

now $\frac{n}{a (r + H) + n}$ does not vary much with height and we may take

$$\Delta\theta = \frac{\bar{n}}{a (r + \bar{H}) + n} \Delta B = \frac{\bar{n} \Delta B}{\Delta n (r + \bar{H}) + \bar{n} \Delta B}$$

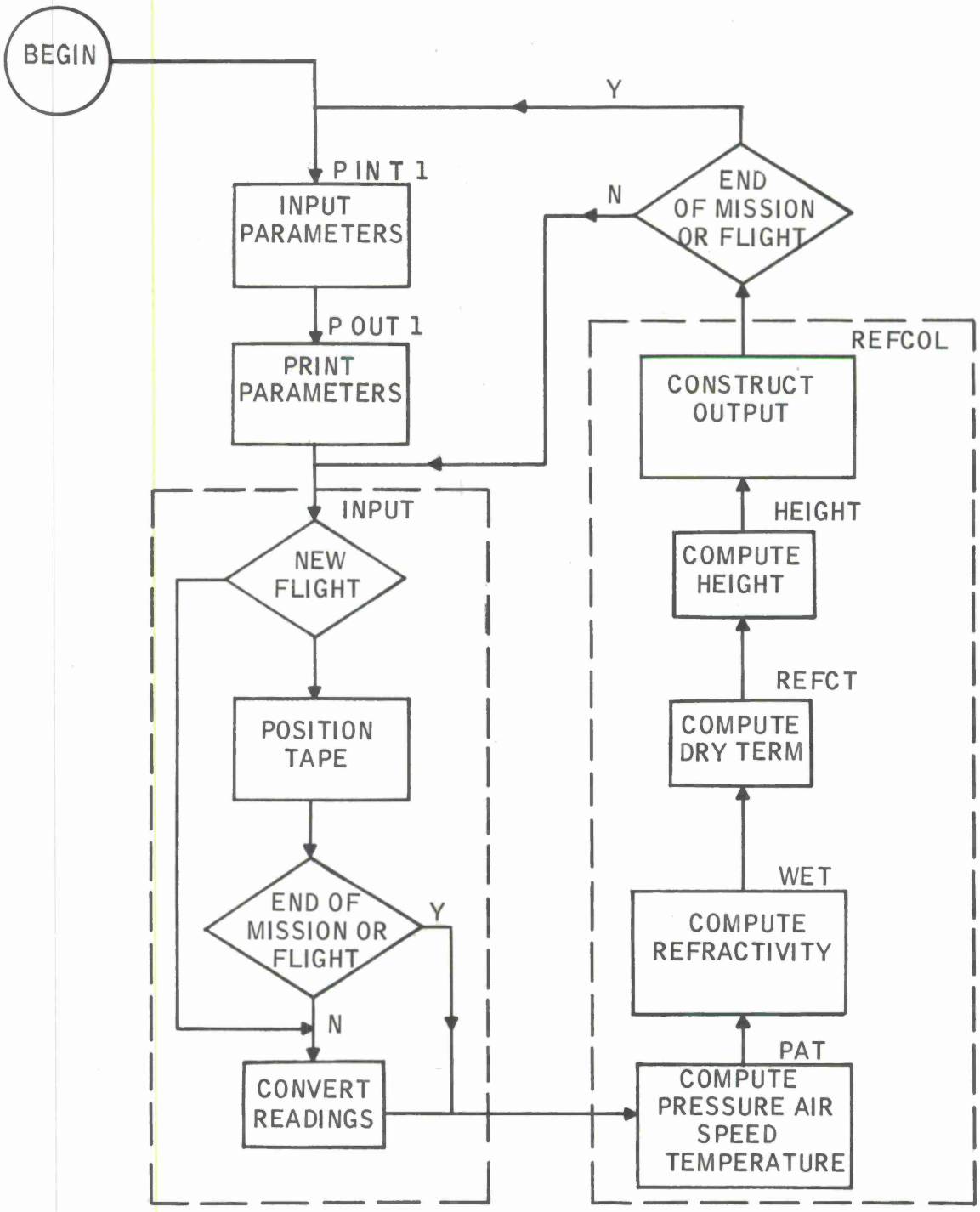
which is the formula used by TRACE.

APPENDIX I

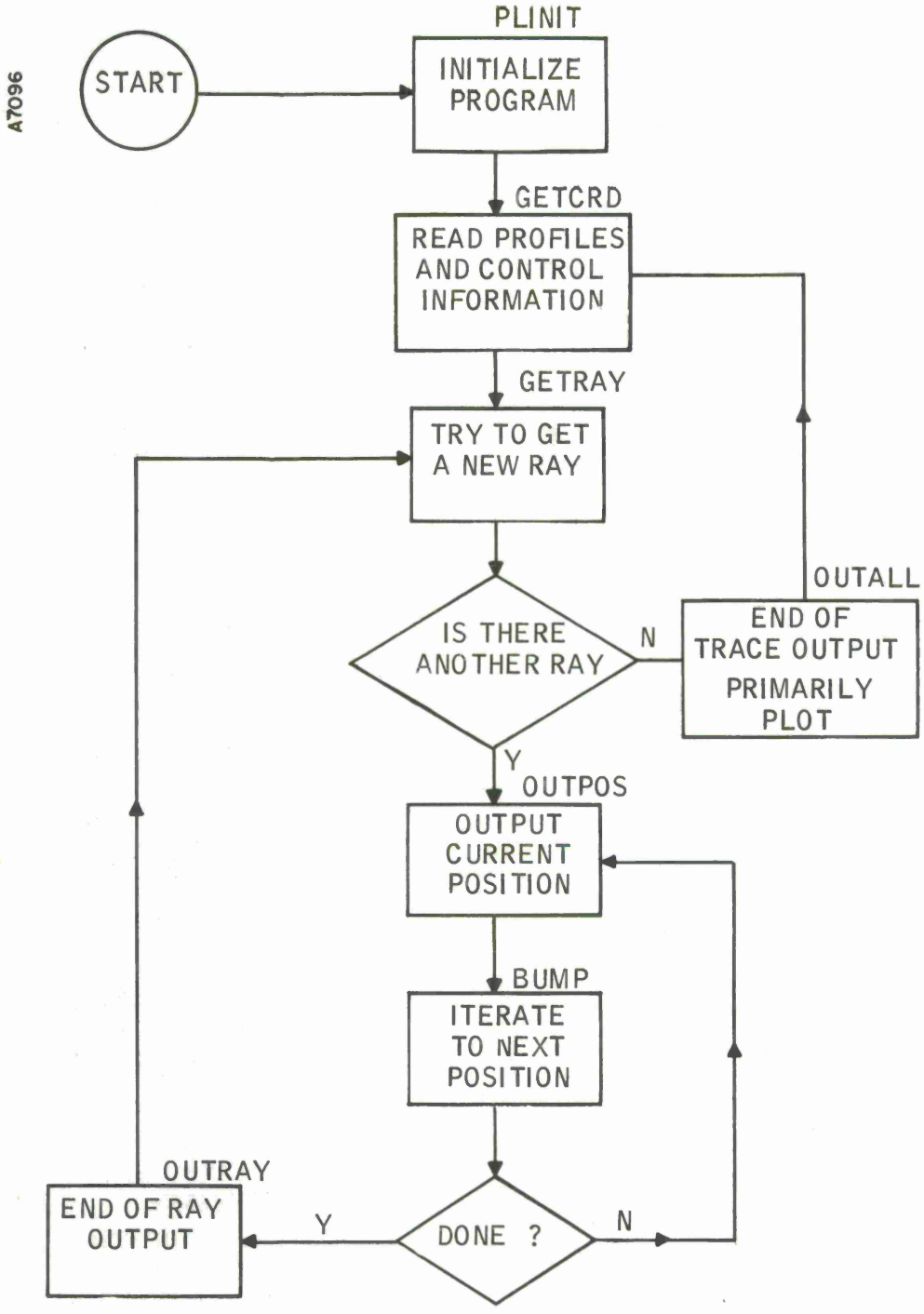
COMPUTER PROGRAM LISTINGS

This Appendix contains listings of all the programs described in this report. They do not include the assembly language plotting routines. These are the standard routines written by North American Aviation, and available from Stromberg-Carlson.

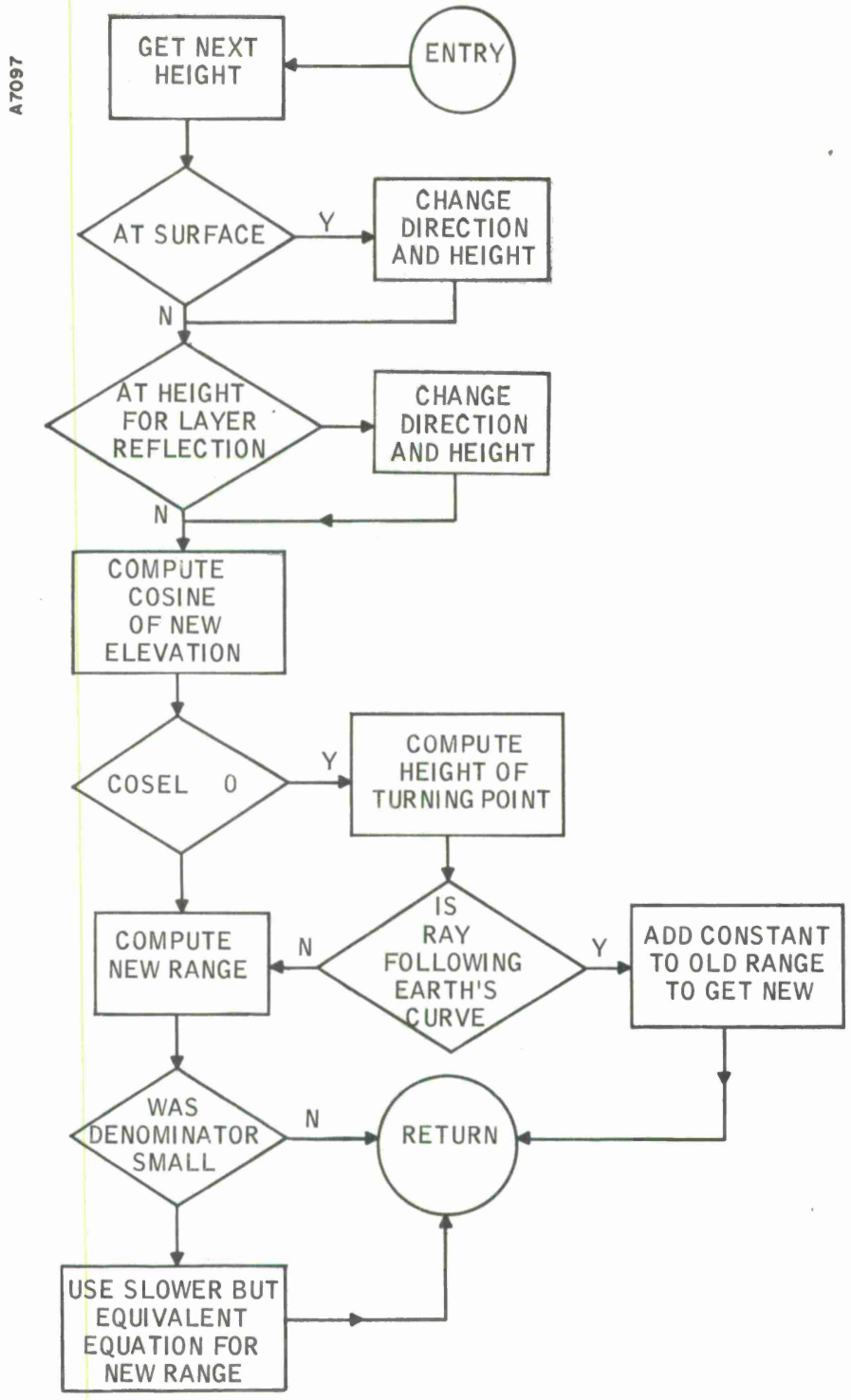
In order to accommodate the method of reproduction some cards in these programs are split into two lines. It is always obvious when this has been done.



BROAD FLOW CHART OF RAWCON



OVERALL PROGRAM LOGIC OF TRACE



SUBROUTINE BUMP IN TRACE

```
△JOB.
△REWIND B0.
△META8920 SI,B0,L0,C0NC,SET.
          EXTEND
          R0RG     0200
CHARL     EQU      36*254/8
SPACELIM  EQU      8
          BRU      ENDPT          F0R 0PERAT0R T0 BRU T0.
BEGIN     RES      0
          CLA
          STA      RECCNT
          BRM      QUEST
          PZE      P0SMES
          BRU      STRTPT
*
*                  THIS P0SITI0NING EFF0RT IS DIRECTED.
*         T0WARD FINDING A TRIPLE E0F.  AND
                             P0SITI0NING THE TAPE
*                  BETWEEN THE SEC0ND AND THIRD E0FS.
*                  IT IS M0RE EL8B0RATE THAN SEEMS NECCESSARY
*                  PRPBLEMS WITH THE TAPE UNITS.
*
SKIPFILE  BRM      TAPEWAIT
SF1       BRM      TESTFWD
          BRU      $+2
          BRU      SF1            N0T AN E0F.
          BRM      TESTFWD
          BRU      $+2            2ND E0F.
          BRU      SF1
          BRM      TESTFWD
          BRU      $+2            3RD E0F.
          BRU      SF1
SF2       BRM      TESTBCK
          BRU      SF2
SF3       BRM      TESTFWD
          BRU      $+2
          BRU      SF3
          BRM      TESTFWD
          BRU      STRTPT
          DIR
          HLT
STRTPT    RES      0                   START THE PAPER TAPE
          LDA      =BUF                SET UP F0R START 0F REC
          STA      PTR
          LDA      =CHARL//3-1
          STA      CHARCT
          LDX      =-3
          STB      SPACES
          CLA
```

```
         CAT
         BRU     $-1
         EOM     06204
WIMLDR   WIM     INPT                GET A WORD
                              WHICH MINGT BE LEADER.
         LDA     INPT
         ETR     =0377               GEY BYTE
         SKE     =0
         BRU     WIM+1               GO CONTINUE.
         BRU     WIMLDR
STRTREC  LDA     =BUF                SET UP START OF RECORD
         STA     PTR                 PTR TO
                              NEXT WORD IN OUTPUT BUFFER.
         LDA     =CHARL//3-1
         STA     CHARCT              CHARACTER COUNTER.
         CAT
         BRU     $-1
         EOM     06204
STRTWD   LDX     =-3                 3 8-BIT
                              CHARACTERS TO A WORD.
WIM      WIM     INPT                GET NEXT CHARACTER.
         LDA     INPT
         ETR     =0377
         LDB     =-SPACELIM
         SKE     =0                  TEST FOR BLANK TAPE.
         STB     SPACES
         MIN     SPACES              BUMP COUNT.
         SKN     SPACES
         BRU     ENDPT
         CLB
ASSEM    EXU     LSH,2               ALIGN CHARACTER PROPERLY.
         EXU     MRGNOP,2            MERGE 2ND AND 3RD CHARS.
         STA     *PTR
         BRX     WIM                 GO GET NEX CHARACTER.
         MIN     PTR                 WORD IS COMPLETE BUMP IT.
         SKR     CHARCT              CHECK CHAR COUNT.
         BRU     STRTWD              MORE TO GO.
         DSC                         WRITE OUT RECORD NOW.
         WTPBIN  1,BUF,4*(CHARL//3)
         BETR    ENDMT
         LDA     =CHARL//3-1
         BRM     PUTREC
         BRU     STRTREC
*
*        ROLL OF TAPE IS FINISHED. SEE WHAT TO DO NEXT.
ENDPT    DSC
         LDA    =CHARL//3
         SUB     CHARCT
         STA     CHARCT
```

```
          WTPBIN  1,BUF,(CHARCT)     AND WRITE THAT MANY.
          BETP    ENDMT
          LDA     CHARCT
          SUB     =1
          BRM     PUTREC
          WTMARK  1
          BRM     QUEST                  FIND OUT
                                  IF THERE ARE MORE ROLLSIN
          PZE     EOMMES                 THIS MISSION.
          BRU     STRTPT                 MORE ROLLS.
                                  ONE EOF IS ENOUG.
          WTMARK  1
          BRM     QUEST
          PZE     EOTMES                 ARE THERE MORE MISSIONS.
          BRU     STRTPT                 YES
          WTMARK  1
          REWIND  1
          BRM     QUEST                  ARE THERE MORE MAG TAPES.
          PZE     TAPMES
          BRU     BEGIN                  YES.
          BRU     1
*
ENDMT     BACKSPACE 1,(2)
          RTPBIN  1,BUF                  READ A RECORD
          BTMK    LSTMS                  IF THIS
                                  IS END OF MSISION BRU
          BRU     ENDMT                  OTHW CONTINUE
                                  BACK SPACEING.
LSTMS     WTMARK  1                      PUT ON A 3RD EOF .
          REWIND  1
          TYPE    REWMES
          TYPE    RE1MES
          BRU     BEGIN                  AND START OVER.
          PAGE
PUTREC    PZE                            OUTPUT A RECORD.
          MIN     RECCNT                 BUMP RECORD COUNT
          BPT     2
          BRR     PUTREC
          STA     WORDCNT
          BLANK   LINE,33
          MOVE    RECMES,1,LINE,2,6
          BINBCD  LINE,9,5,RECCNT
          PRINT   LINE,'J'               PRINT HEADER.
          LDA     =BUF
          STA     PTR                    START AT
                                  BEGINNING OF BUFFER
          LDA     =-1
          STA     NEWLINE                FORCE NEW LINE.
PUTL      LDX     =-3
```

```
         LDA     *PTR
         EXU     RSH,2
         ETR     =0377
         BRM     PUTCNV
         BRX     PUTL+1
         MIN     PTR             BUMP POINTER IN BUFFER.
         SKR     WORDCNT         BUMP COUNT.
         BRU     PUTL            KEEP GOING.
         SKN     NEWLINE         STARTING A NEW LINE.
         BRU     $+2             NO.
         BRR     PUTREC          YES. RETURN.
         PRINT   LINE
         BRR     PUTREC
*
PUTCNV   PZE                     CONVERT A CHARACTER
         STA     TEMP1            SAVE WORD
         SKN     NEWLINE         SHOULD
                                 WE START A NEW LINE.
         BRU     SHIFT           NO.
         LDA     =LINE           YES RESET PTR.
         STA     LINEPTR
         MIN     NEWLINE         RESET INDICATOR.
         STX     TEMP2
         BLANK   LINE,33
         LDX     TEMP2
SHIFT    RES     0
         LDA     TEMP1
         ETR     =07
         STA     *LINEPTR        LEAST SIGNIFICANT
                                 OCTAL DIGIT.
         LDA     TEMP1
         LSH     3
         ETR     =0700           NEXT OCTAL DIIT
         MRG     *LINEPTR
         STA     *LINEPTR
         LDA     TEMP1
         LSH     6
         ETR     =070000         LAST DIGIT.
         MRG     *LINEPTR
         MRG     =' 000'
         STA     *LINEPTR        FINE FOR M OF WORD.
         MIN     LINEPTR         BUMP PTR.
         LDA     LINEPTR
         SKG     =LINE+29        END OF LINE.
         BRR     PUTCNV          NO.
         PRINT   LINE            YES.
         SKR     NEWLINE
         BRU     $-1             IN CASE OF ERROR.
         BRR     PUTCNV
```

```
          PAGE
QUEST     PZE                         ASK QUESTIONS.
          LDA       QUEST
          ETR       =037777           EXTRACT ADDR.
          ADD       =040001           TURN ON
                                    INDR BIT AND BUMP.
          STA       QUEST
          TYPE      *QUEST
INQ       TYPEIN    BUF               GET RESPONES.
          LDA       BUF
          SKE       ='Y   '           YES RESPONE
          BRU       $+2               NO.
          BRR       QUEST             YES RETURN.
          SKE       ='N   '           NO RESPONE.
          BRU       INQNG             NO.  TRY AGAIN.
          MIN       QUEST             TAKE NEGATIVE EXIT.
          BRR       QUEST
INQNG     TYPE      NGMES
          BRU       INQ
TESTFWD   PZE
          CAT                         WAIT FOR CHANNEL
          BRU       $-1
          SKN       DIR               IF TAPE IS GOING FORWARD
          BRU       $+2               DONT HAVE TO
                                      WAIT FOR IT TO COME RDY
          BRM       TAPEWAIT          OTHW. WAIT
          SFB       0,1,4
          WIM       BUF
          DSC
          CLA                         INDICATE GOING FORWARD
          STA       DIR
          TFT                         EOF
          BRR       TESTFWD
          MIN       TESTFWD           NO.
          BRR       TESTFWD
TESTBCK   PZE
          CAT
          BRU       $-1
          SKN       DIR               CHECKDIRECTION
          BRM       TAPEWAIT          GOING FORWARD.
          SRB       0,1,4
          WIM       BUF
          DSC
          LDA       =-1               INDICATE GOING BACKWARD
          STA       DIR
          TFT                         TEST FOR EOF.
        BRR       T+STBCK
          MIN       TESTBCK           NO.
          BRR       TESTBCK
```

```
TAPEWAIT PZE
         TRT     0,1
         BRR     TAPEWAIT
         BRU     $-2
         RSH     16
         RSH     8
         NØP
RSH      EQU     $
         LSH     16
         LSH     8
         NØP
LSH      EQU     $
         NØP
         MRG     *PTR
         MRG     *PTR
MRGNØP   EQU     $
EØMMES   TEXT    <ARE THERE ANY MØRE RØLLS
                          FØR THIS MISSIØN >
EØTMES   TEXT    <ARE THERE ANY MØRE MISSIØNS
                          FØR THIS MAG TAPE >
RECMES   TEXT    <RECØRD>
TAPMES   TEXT    <ARE THERE MØRE MAGNETIC TAPES >
PØSMES   TEXT    <IS THIS A NEW MAG TAPE >
REWMES   TEXT    <END ØF MAGNETIC TAPE. MØUNT
                          NEW TAPE, AND RESTART >
RE1MES   TEXT    <CURRENT MISSIØN. >
NGMES    TEXT    <LEGAL RESPØNSES ARE Y ØR N. >
LINE     RES     33
TEMP1    PZE
TEMP2    PZE
DIR      PZE
WØRDCNT  PZE
RECCNT   DATA    0,0
NEWLINE  PZE
LINEPTR  PZE
CHARCT   PZE
PTR      PZE
SPACES   PZE
XSAV PZE
ASAV PZE
BSAV PZE
INPT     PZE
BUF      RES     500
         END     BEGIN
△EØF.
△ENDJØB.
△JØB.
△REWIND BØ.
△LØAD 0,GØ.
```

```
$IBFTC QUAK    NODECK
C  PROGRAM TO CONTROL INPUT OUTPUT DEVICIES
C  CALLS QUACK WHICH PROCESSES THE DATA
C  COMMON      INPUT - DATA READ INTO
C              LCODE - ARRAY IN WHICH UNPACK THE DATA
C  COMMON /X/ MON(13) - MONTHS TO BE
                 PROCESSED WITH OVERFLOW SLOT
C              INUM - NUM OF MONTHS TO BE PROCESSED, MAX 13
C              IAREA(5,4) - AREAS TO
                 BE PROCESSED, WITH OVERFLOW SLOT
C              INUMX - NUM OF AREAS TO BE PROCESSED, MAX 4
C              ISUM(4,4,99) - 4 GROUPS
                 OF CHARACTERISTICS FOR EACH AREA
C              IST(200,30) - STATION AREA
C              NUMST - NUM OF STATIONS, MAX 200
C              IXXI - NUMBER OF SOUNDINGS PROCESSED,
C                   ZERO AT START OF NEW MONTH
C  DIMENSION   INPUT(316)  315 WORDS PLUS OVERFLOW, MAX 315
C              LCODE(6,315)  6*315 WORDS - UNPACK ARRAY
C              IDAY(12) - NUM DAYS IN
                 MONTH IN A FORMAT, WHERE MONTH IS
C                  GIVEN BY THE INDEX
C
C
      COMMON INPUT,LCODE
      COMMON /X/ MON(13),INUM,IAREA(5,
                 4),INUMX,ISUM(4,4,99),IST(200,30),
     1NUMST,IXXI
      DIMENSION INPUT(316),LCODE(6,315),IDAY(12)
      DATA IDAY(1),IDAY(2),IDAY(3),IDAY(4),
                 IDAY(5),IDAY(6),IDAY(7),
     1IDAY(8),IDAY(9),IDAY(10),IDAY(11),IDAY(12)/
     26H   31,6H    28,6H    31,6H
                   30,6H    31,6H    30,6H    31,
     36H    31,6H    30,6H    31,6H    30,6H    31/
      WRITE(6,300)
  300 FORMAT(1H1)
C
C  INITIALIZE MONTH AND AREA COUNTER
      INUM=0
      INUMX=0
C
C  READ IN MONTHS TO BE PROCESSED IN TIME ORDER
C  SETS MONTH COUNTER, INUM  MIN=1  MAX=12 IF OTHER STOP
C  BLANK CARD MARKS END OF DATA
      DO 18 I=1,13
      INUM=INUM+1
      READ(5,4)MON(INUM)
    4 FORMAT(I2)
```

```
   18 IF(M0N(INUM).EQ.0)G0T085
  888 PRINT 5013
 5013 F0RMAT(/,23H M0NTH REQUEST IN ERR0R,/)
      ST0P
    5 INUM=INUM-1
      IF(INUM.LT.1)G0T0888
      PRINT 19,(M0N(I),I=1,INUM)
   19 F0RMAT(/,24H M0NTHS T0 BE PR0CESSED,,12(I3),/)
C
C  READ IN AREAS T0 BE PR0CESSED
C  SET ATEA C0UNTER, INUMX  MIN=1  MAX=4 IF 0THER ST0P
C  BLANK CARD MARKS END 0F DATA
      D0 218 I=1,5
      INUMX=INUMX+1
      READ(5,6)(IAREA(INUMX,J),J=1,4)
    6 F0RMAT(4I6)
  218 IF(IAREA(INUMX,1).EQ.0)G0T015
 1888 PRINT 5113
 5113 F0RMAT(/,29H LAT AND L0G REQUEST IN ERR0R,/)
      ST0P
   15 INUMX=INUMX-1
      IF(INUMX.LT.1)G0T01888
      PRINT 119,((IAREA(I,J),J=1,4),I=1,INUMX)
  119 F0RMAT(/,22H AREAS T0 BE L00KED
                  AT,/,3X,4HLAT1,3X,4HLAT2,3X,
     14HL0G1,3X,4HL0G2,/,4(4I7,/),//)
C
C  INITIALIZE ALL FLAGS AND C0UNTERS BEF0RE STARTING
      ITAPE=0
      IFLAG=0
      IXXI=0
      ICNT=1
      PRINT 9123
 9123 F0RMAT(34H NEED BLANK TAPE 0N UNIT B5 AND B6,/,
     122H M0UNT TAPE 0N UNIT A5,//)
      G0T024
C
C  REWIND PREVI0US INPUT TAPE AND WRITE
                  0PERAT0R INSTRUCTI0NS
C  0PEN NEW FILE, SET FLAG F0R NEXT INPUT TAPE (IMT)
C  INCREMENT INPUT TAPE C0UNTET (ITAPE)
C  START 0F L00P
   10 IF(IMT.EQ.-1)G0T022
      REWIND 10
      PRINT 5011
 5011 F0RMAT(/,22H M0UNT TAPE 0N UNIT A5,
     1/,24H UNM0UNT TAPE 0N UNIT A6,/)
   24 CALL 0PEN1
      IMT=-1
```

```
      ITAPE=ITAPE+1
      GOTO212
   22 CONTINUE
      REWIND 9
      PRINT 5002
 5002 FORMAT(/,22H MOUNT TAPE ON UNIT A6,
     1/,24H UNMOUNT TAPE ON UNIT A5,/)
      CALL OPEN2
      IMT=1
      ITAPE=ITAPE+1
C
C  READY TO PROCESS DATA
C  IF IFLAG 0, BEGINNING OF RUN
  212 IMON=MON(ICNT)
      CALL QUACK(IMT,IMON,IFLAG)
C
C  IXXI, TOTAL NUMBER OF SOUNDINGS USED FOR PRESENT MONTH
C  IF IFLAG 2, MONTH REQUEST DOES NOT MATCH DATA
C  IF IFLAG 1, NEED NEW MONTH
C  IF IFLAG -1, NEED NEW TAPE
C  IF IFLAG -2, COULD NOT FIND STARTING MONTH
      PRINT 6082,IFLAG,NUMST,IXXI
 6082 FORMAT(/,5H FLAG,I3,5X,19H NUMBER OF STATIONS,I5,5X,
     120H NUMBER OF SOUNDINGS,I5,/)
      IF(IFLAG.EQ.2)GOTO2778
      IF(IFLAG.EQ.1)GOTO602
      IF(IFLAG.EQ.-1)GOTO603
C
C  STARTING MONTH NOT ON TAPE
      PRINT 1819
 1819 FORMAT(/,27H STARTING MONTH NOT
                  ON TAPE,/,14H FORCED FINISH,/)
      GOTO816
C
C  MONTH REQUEST DOES NOT MATCH INPUT DATA
 2778 ICNT=ICNT-1
      PRINT 2887,(MON(I),I=1,ICNT)
 2887 FORMAT(/,55H NEXT MONTH REQUEST
                  DOES NOT MATCH WITH NEXT INPUT DAT
     1A,/,19H PROCESSED MONTHS, ,12(I3),/)
      GOTO816
C
C  NEED NEW MONTH
  602 CALL OUTPUT(IMON)
      IF(ICNT.EQ.INUM)GOTO1777
C
C  PROCESS NEXT MONTH
      ICNT=ICNT+1
      IXXI=0
```

```
      GOTO212
C
C  FINISHED ALL MONTHS DESIRED BUT ADDITIONAL INPUT
 1777 PRINT 1778,(MON(I),I=1,ICNT)
 1778 FORMAT(/,49H ADDITIONAL INPUT
                  BUT FINISHED ALL MONTHS DESIRED,
     1/,8H MONTHS ,12(I3),/)
      GOTO816
C
C  NEED NEW TAPES
  603 PRINT 729
  729 FORMAT(/,53H KEY 35 DOWN FOR ADDITIONAL
                  INPUT, UP TO FINALIZE JOB,
     1/)
      PAUSE
      CALL KEYS(WORD)
      IF(IBIT(WORD,35).EQ.1)GOTO10
C
C  NO ADDITIONAL INPUT
C CHK SUFF DAYS PRES TO CNT MONTH OR ONLY ONE MO TO PROCESS
      IF(INPUT(4).NE.IDAY(IMON).AND.INUM.NE.1) GO TO 705
C
C  FINSIHED PRESENT MONTH
      CALL OUTPUT(IMON)
      IF(ICNT.LT.INUM)GOTO704
C
C  ALL MONTHS
      PRINT 2771,(MON(I),I=1,ICNT)
 2771 FORMAT(/,30H FINISHED ALL MONTHS DESIRED, ,12(I3),/)
      GOTO 816
C
C  PROCESSED SOME MONTHS
  705 ICNT=ICNT-1
      IF(ICNT.LT.1)GOTO614
  704 PRINT 701,(MON(I),I=1,ICNT)
  701 FORMAT(/,24H PROCESSED SOME MONTHS, ,12(I3),/)
      GOTO816
C
C  NO OUTPUT
  614 PRINT 714
  714 FORMAT(/,30H NO OUTPUT, INPUT INSUFFICIENT,/)
C
C  TAKE CARE OF INPUT OUTPUT DEVICIES
  816 IF(IMT.EQ.1)GOTO811
      REWIND 9
      END FILE 11
      END FILE 12
      REWIND 11
      REWIND 12
```

```
      PRINT 2001, ITAPE
 2001 FORMAT(/,22H UNMOUNT A5, B5 AND
                  B6,/,27H NUMBER OF INPUT TAPES USE
     1D,I3,/,9H FINISHED,/)
      STOP
  811 REWIND 10
      END FILE 11
      END FILE 12
      REWIND 11
      REWIND 12
      PRINT 2002, ITAPE
 2002 FORMAT(/,22H UNMOUNT A6, B5 AND
                  B6,/,27H NUMBER OF INPUT TAPES USE
     1D,I3,/,9H FINISHED,/)
      STOP
      END
$IBFTC WORK    NODECK
C  PROGRAM TO CHANGE FORMAT OF SOUNDING FROM ALPHANUMERIC TO
C  FLOATING PT AND INTERGER.      COMPILIES
                  STATISTICS ON THE QUALITY
C  OF THE STATION.  CALLS DUCT WHICH
                  LOOKS FOR LAYERS AND COMPILIES
C  STATISTICS.     CHECKS DATA TO SEE
                  IF PROCESSING MONTH OF DATA
C  DESIRED, IF NOT RETURN.
C  DIMENSION  INPUT(316),KPUT(21,15) INPUT ARRAY
C             LCODE(6,315),FCODE(6,315)
                   USED TO UNPACK AND EVALUATE
C                   LEVEL DATA
C             IEND(6,9),FEND(6,9)  USED
                  TO UNPACK AND EVALUATE
C                   END DATA
C             ILT(12)   USED AS A GENERAL UNPACKING ARRAY
C  DATA       IRAOB   ALPHANUMERIC RAOB IDENTIFIER
C             IWXV   OCTAL EQUIVALENT RECORD MARK
C
      SUBROUTINE QUACK(IJLM,IMON,IFLAG)
      COMMON INPUT,LCODE
      COMMON /X/ MON(13),INUM,IAREA(5,
                  4),INUMX,ISUM(4,4,99),IST(200,30),
     1NUMST,IXXI
      DIMENSION INPUT(316),KPUT(21,15),
                  LCODE(6,315),FCODE(6,315),
     1IEND(6,9),FEND(6,9),ILT(12)
      EQUIVALENCE (INPUT,KPUT),(LCODE,FCODE),(IEND,FEND)
      DATA IRAOB,IWXV/6HRAOB  ,0606060606072/
C
C  IF IFLAG 0, LOOKING FOR FIRST MONTH DESIRED
C  IF IFLAG -1, NEW INPUT TAPE
```

```
C  IF IFLAG 1, NEW MONTH
C
C
C  START
      IF(IFLAG.EQ.-1)GOTO2
C
C  INTIALIZE FOR PROCESSING OF NEW MONTH
      IXFLA=0
      NUMST=0
C
C  ZERO ISUM ARRAY
      DO 1101 I=1,INUMX
      DO 1101 J=1,4
      DO 1101 K=1,99
 1101 ISUM(I,J,K)=0
      CALL OUTX(1,0.,0.,0.,0.)
      IF(IFLAG.EQ.1)GOTO312
C
C  START OF LOOP
    2 CONTINUE
C
C  REMOVE C FROM FOLLOWING CARD IF WANT
C                 TO STOP PROCESSING AFTER A
C                          A GIVEN NUMBER OF SOUNDINGS
C     IF(IXXI.GT.     )GOTO4076
C
C  READ RECORDS
      CALL IN(L,LOCK,IJLM)
      IF(IFLAG.EQ.0.AND.LOCK.EQ.1)GOTO1333
      IF(LOCK.EQ.1)GOTO778
C
C  TEST TO SEE IF WANT TO EVALUATE LEVEL
C                 DATA OF PRESENT SOUNDING
  312 IF(INPUT(1).NE.IRAOB)GOTO2
      CALL DECODE(INPUT(5),ILT(1),1)
      IF(ILT(5).EQ.48)ILT(5)=0
      IMONX=10*ILT(5)+ILT(6)
      IF(IMONX.NE.IMON)GOTO4062
C
C  EVALUATE LEVEL DATA
C
C  TEST FOR LAST RECORD MARK
      IF(INPUT(L-1).EQ.IWXV.AND.INPUT(L).EQ.IWXV)L=L-1
      IF(INPUT(L).NE.IWXV)L=L+1
C
C  INITIALIZE OVERFLOW FLAG
C  CHECK SIZE OF SOUNDING THAT CAN READ IN
      JFLAG=0
      IF(L.LE.315)GOTO808
```

```
C
C  FLAG IF NOT READ IN COMPLETE SOUNDING
C  OVERFLOW, HAVE AT LEAST 48 DATA LEVELS,
C                  BUT DO NOT HAVE END INFO
      JFLAG=88
      L=322
C
C  IREC, NUMBER OF COMPLETE LOGICAL RECORDS
C  IREM, NUMBER OF DATA WORDS REMAINING LESS END DATA
  808 IREC=L/21
      IREM=MOD(L,21)-11
      IF(IREM.EQ.-11)IREM=-10
      IF(IREM)28,28,3
   28 IREC=IREC-1
      IREM=IREM+20
C
C  DECODE THROUGH LAST LEVEL DATA POINT
    3 CALL DECODE(INPUT(9),LCODE(1,1),12)
      K=13
      IF(IREC.LT.2)GOTO4
      DO 10 I=2,IREC
    - CALL DECODE(KPUT(1,I),LCODE(1,K),20)
   10 K=K+20
    4 CALL DECODE(KPUT(1,IREC+1),LCODE(1,K),IREM)
C
C  NUMBER OF PRESSURE LEVELS WITHIN THE SOUNDING
C  DO NOT EXCEPT SOUNDING IF LESS THAN 4 PRESSURE LEVELS
      LL=(L-(19+(L/21)))/6
      IF(IREM.EQ.10)LL=(L-(18+(L/21)))/6
      L=LL
      IF(L.LT.4)GOTO2
C
C  EVALUATE LEVEL DATA
C  N CONTROLS DATA WITHIN EACH LEVEL
C  NN CONTROLS NUMBER OF LEVELS PROCESSED
C  II WORD WITHIN DATA
C  JJ LEVEL OF DATA
      N=0
      NN=0
      DO 99 J=1,315
      IF(J.EQ.N+7)N=N+6
      II=J-N
      JJ=1+NN
      IF(JJ.GT.L)GOTO98
      IF(II/6.EQ.1)NN=NN+1
      DO 12 I=1,6
      IF(LCODE(I,J).EQ.16)LCODE(I,J)=0
   12 IF(LCODE(I,J).EQ.48)LCODE(I,J)=0
      MARK=0
```

```
      DO 11 I=1,5
      IF(LCODE(I,J).EQ.32)GOTO563
   11 CONTINUE
      GOTO141
  563 MARK=1
      LCODE(I,J)=0
C
C  CHECK FOR FLOATING PT
  141 IF(LCODE(5,J).EQ.27)GOTO31
C
C  CHECK FOR D IN FIRST CHARACTER
      IF(LCODE(6,J).EQ.20)GOTO32
      LCODE(II,JJ)=LCODE(6,J)+10*LCODE(5,J)+100*LCODE(4,J)
     1+1000*LCODE(3,J)+10000*LCODE(2,J)
      IF(MARK.EQ.1)LCODE(II,JJ)=-LCODE(II,JJ)
      GOTO99
   31 CONTINUE
      FCODE(II,JJ)=FLOAT(LCODE(6,J))*.1+FLOAT(LCODE(4,J))
     1+FLOAT(LCODE(3,J))*10.0+FLOAT(LCODE(2,J))*100.0
      IF(MARK.EQ.1)FCODE(II,JJ)=-FCODE(II,JJ)
      GOTO99
C
C  REPLACE WIND DIRECTION.WITH 999999 IF INCONSISTENT
   32 LCODE(II,JJ)=999999
   99 CONTINUE
C
C  SEE IF EXCEPTABLE VALUES FOR PRES, TEM, AND DEW PT
C  IF NOT, DO NOT CONSIDER SOUNDING
      DO 6099 J=1,LL
      IF(LCODE(1,J).GT.1100.OR.LCODE(1,J).LT.0)GOTO2
      IF(FCODE(3,J).GT.75.0.OR.FCODE(3,J).LT.-100.0)GOTO2
      IF(FCODE(4,J).EQ.99.0)GOTO6099
      IF(FCODE(4,J).GT.FCODE(3,J).OR.FCODE(4,
                  J).LT.-100.0)GOTO2
 6099 CONTINUE
C
C  CHECK PRESSURE OF FIRST FOUR LEVEL
                  DATA POINTS TO SEE IF WILL
C  EXECPT SOUNDING
   98 DO 7389 I=1,4
 7389 IF(LCODE(1,I).LT.100)GOTO2
C
C  WILL EXCEPT SOUNDING, INCREMENT SOUNDING
                  COUNTER, CLEAR IFLAG
      IXXI=IXXI+1
      IFLAG=99
C
C  DECODE END DATA
      IF(JFLAG.EQ.88)GOTO767
```

```
      KK=IREM+2
      IF(KK.GT.20)GOTO511
      K=21-KK
      IF(K.GT.9)K=9
      CALL DECODE(KPUT(KK,IREC+1),IEND(1,1),K)
      IF(K.EQ.9)GOTO46
      CALL DECODE(KPUT(1,IREC+2),IEND(1,K+1),9-K)
      GOTO46
  511 CALL DECODE(KPUT(KK-20,IREC+2),IEND(1,1),9)
C
C  EVALUATE END DATA
   46 DO 76 I=1,9
      DO 248 II=1,6
      IF(IEND(II,I).EQ.16)IEND(II,I)=0
  248 IF(IEND(II,I).EQ.48)IEND(II,I)=0
      IF(I.EQ.4)GOTO76
      IF(I.EQ.6)GOTO76
      IF(I.EQ.3)GOTO74
      IEND(1,I)=IEND(6,I)+IEND(5,I)*10+IEND(4,I)*100
     1+IEND(3,I)*1000+IEND(2,I)*10000
      GOTO76
   74 MARK=0
      DO 1112 II=1,6
 1112 IF(IEND(II,I).EQ.32)GOTO1113
      GOTO174
 1113 IEND(II,I)=0
      MARK=1
  174 FEND(1,I)=FLOAT(IEND(6,I))*.1+FLOAT(IEND(4,I))
     1+FLOAT(IEND(3,I))*10.0+FLOAT(IEND(2,I))*100.0
      IF(MARK.EQ.1)FEND(1,I)=-FEND(1,I)
   76 CONTINUE
  767 CONTINUE
C
C  IF WANT TO PRINT OUT EVALUATED DATA,
                  REMOVE C FROM FOLLOWING CARDS
C     WRITE(6,6092)(INPUT(I),I=1,8)
C6092 FORMAT(/,8(1X,A6))
C     DO 6098 KJ=1,LL
C6098 WRITE(6,6038)(LCODE(K,KJ),K=1,2),(FCODE(K,KJ),K=3,4),
C    1(LCODE(K,KJ),K=5,6)
C6038 FORMAT(2I8,2F9.2,2I8)
C     IF(JFLAG.EQ.88)GOTO1489
C     WRITE(6,6048)(IEND(1,K),K=1,2),FEND(1,3),IEND(1,5),
C    1(IEND(1,K),K=7,9)
C6048 FORMAT(2I8,F9.2,4I8)
C1489 CONTINUE
C
C  COMPUTE LAT AND LOG
      CALL DECODE(INPUT(6),ILT(1),2)
```

```
      MAK1=0
      MAK2=0
      DO 9028 I=1,12
      IF(ILT(I).EQ.16)ILT(I)=0
      IF(ILT(I).NE.32)GOTO9028
      IF(ILT(I).EQ.48)ILT(I)=0
      IF(I.LE.6)MAK1=1
      IF(I.GE.7)MAK2=1
      ILT(I)=0
 9028 CONTINUE
      LAT=ILT(2)*10000+ILT(3)*1000+ILT(4)*
                  100+ILT(5)*10+ILT(6)
      IF(MAK1.EQ.1)LAT=-LAT
      LOG=ILT(8)*10000+ILT(9)*1000+ILT(10)*
                  100+ILT(11)*10+ILT(12)
      IF(MAK2.EQ.1)LOG=-LOG
C
C  FLAG IF SIG LEVELS
      DO 8109 I=1,L
 8109 IF(MOD(LCODE(1,I),50).GT.0)GOTO8110
      ISIG=0
      GOTO8111
 8110 ISIG=1
 8111 CONTINUE
C
C  PUT DATA IN STATION ARRAY
C
C  ARRAY IST(I,J)  I -  INDEX FOR STATIONS
                      J - COUNTERS FOR A
C  GIVEN STATION     1 NUM  2 LAT  3
                  LOG  4 EL  5 NUM TOTAL SND
C  6 NUM SIG LEVELS  7 NUM OF SUR MEASURE
                   8 AVG PRES  9 AVG TEM
C  10 AVG DEW PT
C
      IF(NUMST.EQ.0)GOTO1756
      DO 1864 KLM=1,NUMST
 1864 IF(INPUT(2).EQ.IST(KLM,1))GOTO1865
C
C  PREPARE ARRAY FOR NEW STATION
 1756 IF(NUMST.EQ.200)GOTO8900
      NUMST=NUMST+1
      KLM=NUMST
      IST(KLM,1)=INPUT(2)
      IST(KLM,2)=INPUT(6)
      IST(KLM,3)=INPUT(7)
      IST(KLM,4)=INPUT(8)
      DO 8113 I=5,30
 8113 IST(KLM,I)=0
```

```
C
C  TREAT AS OLD DATA
 1865 IST(KLM,5)=IST(KLM,5)+1
      IF(ISIG.EQ.1)IST(KLM,6)=IST(KLM,6)+1
      IF(IEND(1,5).EQ.0.OR.JFLAG.EQ.88)GOTO7341
      IST(KLM,7)=IST(KLM,7)+1
      IST(KLM,8)=IST(KLM,8)+LCODE(1,1)
      DEL=.5
      IF(FCODE(3,1).LT.0.0)DEL=-DEL
      IST(KLM,9)=IST(KLM,9)+IFIX(FCODE(3,1)*10.0+DEL)
      DEL=.5
      IF(FCODE(4,1).LT.0.0)DEL=-DEL
      IST(KLM,10)=IST(KLM,10)+IFIX(FCODE(4,1)*10.0+DEL)
 7341 CALL LAYER(L,KLM,LAT,LOG)
      GOTO2
C
C  DO NOT EXCEED MORE THAN 200 STATIONS
C  IF EXCEED 200 STATIONS WRITE NOTE
 8900 IF(IXFLA.EQ.1)GOTO2
      IXFLA=1
      PRINT 8901
 8901 FORMAT(47H MORE THAN 200 STATIONS,
                  ONLY PROCESS FIRST 200)
      GOTO2
C
C  COULD NOT FIND DESIRED MONTH
 4062 IF(IFLAG.EQ.0)GOTO2
      IF(IXXI.NE.0)GOTO4076
C
C  MONTH REQUEST DOES NOT MATCH DATA
      IFLAG=2
      RETURN
C
C  RETURN, NEW MONTH
 4076 IFLAG=1
      RETURN
C
C  RETURN, END OF FILE
  778 IFLAG=-1
      RETURN
C
C  RETURN, STARTING MONTH NOT ON TAPE
 1333 IFLAG=-2
      RETURN
      END
$IBFTC QT      NODECK
C  PROGRAM TO CREATE A PROFILE OF TEM,
                  DEW PT, HEIGHT, REFRACTIVE
C  INDEX, AND GRADIENT USING DATA GIVEN
                 AND EXPANDING FOR 2MB
```

```
C  PRESSURE LEVELS.
C  LOOKS THROUGH PROFILE TO FIND LAYERS
                  OF CONSTANT GRADIENT AND
C  INCREMENT APPROPRIATE COUNTERS FOR THE GIVEN STATION .
C  DIMENSION  DATA(5,501)  THE ARRAY
                  IN WHICH THE PROFILES ARE MADE
C             DATA(I,J)          I=1 TEMP
                  I=2  DEW PT   I=3  HEIGHT
C                                I=4 REFRACTIVE
                  INDEX  I=5  GRADIENT
C                                J=1  1100 MB  J=501  100 MB
C                                J=OTHER
                   SCALED VALUE IN 2MB LEVELS
C
      SUBROUTINE LAYER(L,IJKL,LAT,LOG)
      COMMON INPUT,LCODE
      COMMON /X/ MON(13),INUM,IAREA(5,
                  4),INUMX,ISUM(4,4,99),IST(200,30),
     1NUMST,IXXI
      DIMENSION INPUT(316),LCODE(6,315),
                  FCODE(6,315),DATA(5,501),IL(6)
      EQUIVALENCE (LCODE,FCODE)
C
C  CHECK FIRST PRES LEVEL
      IF(LCODE(1,1).GT.1100)LCODE(1,1)=1100
C
C  FIND FIRST REF POSITION WITH RESPECT TO PRES
      I1=551-LCODE(1,1)/2
      IBASE=I1
C
C  PUT IN FIRST TEM AND DEW PT
      DATA(1,I1)=FCODE(3,1)
      DATA(2,I1)=FCODE(4,1)
C
C  INSERT TEM AND DEW PT WITH REF TO 2MB PRESSURE LEVELS,
C  AND EXPAND BETWEEN DATA POINTS        1 TEM        2 DEW PT
      DO 88 JK=2,L
      IF(LCODE(1,JK).GT.1100)LCODE(1,JK)=1100
      IF(LCODE(1,JK).LT.100)GOTO89
      I2=551-LCODE(1,JK)/2
      DATA(1,I2)=FCODE(3,JK)
      DATA(2,I2)=FCODE(4,JK)
      DIV=I2-I1
      DEL2=(DATA(1,I2)-DATA(1,I1))/DIV
      MARK=0
      IF(DATA(2,I1).EQ.99.0)MARK=1
      IF(DATA(2,I2).EQ.99.0)MARK=1
      DEL3=(DATA(2,I2)-DATA(2,I1))/DIV
      III=DIV-1.0
```

```
      DO 903 I=1,III
      XI=I
      JJK=I1+I
      DATA(1,JJK)=DATA(1,I1)+DEL2*XI
      DATA(2,JJK)=DATA(2,I1)+DEL3*XI
  903 IF(MARK.EQ.1)DATA(2,JJK)=99.0
   88 I1=I2
      JK=L
C
C  ELIMINATE PORTIONS OF DEW PT PROFILE
                  WHERE DATA DOES NOT EXIST
C  EXPAND BETWEEN GIVEN VALUES AND IF
                  LAST VALUE OF DEW PT IS GONE,
C  ASSUME TO BE -100 AT LOWEST PRESSURE LEVEL GIVEN
   89 IBA=0
      IEN=0
      DO 9901 I=IBASE,I2
      IF(DATA(2,I).NE.99.00)GOTO9905
      IF(IBA.EQ.0)IBA=I-1
      IF(I.NE.I2)GOTO9901
 9905 IF(IBA.EQ.0)GOTO9901
      IEN=I
      IF(IEN.EQ.I2)DATA(2,I2)=-100.0
      DIF=((DATA(2,IEN)-DATA(2,IBA))/FLOAT(IEN-IBA))
      IBA=IBA+1
      IEN=IEN-1
      DO 9902 J=IBA,IEN
      JJ=J-1
 9902 DATA(2,J)=DATA(2,JJ)+DIF
      IBA=0
      IEN=0
 9901 CONTINUE
C
C  SET REF HEIGHT IN METERS
      REF=LCODE(2,1)
      IF(REF.EQ.0.0)GOTO1566
      CALL DECODE(INPUT(8),IL,1)
      DO 888 IJ=1,6
  888 IF(IL(IJ).EQ.48)IL(IJ)=0
      EL=IL(6)+10*IL(5)+100*IL(4)+1000*IL(3)+10000*IL(2)
      REF=REF*3.04801-EL
C
C  COMPUTE THE HEIGHT USING REF HEIGHT
                  AS FIRST HEIGHT     3 HEIGHT
 1566 DATA(3,IBASE)=REF
      I1=IBASE+1
      DO 906 I=I1,I2
      P1=(552-I)*2
      P2=(551-I)*2
```

```
      DATA(3,I)=REF+HEIGH(P1,P2,DATA(1,
                  I-1),DATA(1,I),DATA(2,I-1),
     1DATA(2,I))
  906 REF=DATA(3,I)
C
C  COMPUTE THE REFRACTIVE INDEX        4 REFRACTIVE INDEX
      DO 22 JK=IBASE,I2
   22 DATA(4,JK)=XIND(FLOAT((551-JK)*
                  2),DATA(1,JK),DATA(2,JK))
C
C  COMPUTE THE GRADIENT          5 GRADIENT
      I3=I2-1
      DO 23 JK=IBASE,I3
   23 DATA(5,JK)=((DATA(4,JK+1)-DATA(4,JK))*1000.0)
     1/(DATA(3,JK+1)-DATA(3,JK))+.5
C
C  FIND LAYERS OF CONSTANT GRADIENTS
C  IF LAYER EXISTS, FIND HEIGHT AND THICKNESS
C
      IXFLAG=0
      XMAX=-10000
      DO 666 IIJ=1,10
      XMIN=XMAX
      IF(IIJ.EQ.6)XMIN=-XMIN
      GOTO(701,702,703,704,705,706,707,708,709,710),IIJ
  701 XMAX=-1000
      ISGN=1
      GOTO9817
  702 XMAX=-500
      GOTO9817
  703 XMAX=-150
      GOTO9817
  704 XMAX=-100
      ISGN=2
      WW=-150.0
      GOTO9817
  705 XMAX=-75
      GOTO9817
  706 XMAX=100
      ISGN=3
      WW=75.0
      GOTO9817
  707 XMAX=150
      GOTO9817
  708 XMAX=500
      ISGN=4
      GOTO9817
  709 XMAX=1000
      GOTO9817
```

```
  710 XMAX=10000
C
C  N6, FLAG IF SURFACE AND ELEVATED
                  LAYERS OCCUR WITHIN A GIVEN PROFILE
 9817 N6SR=0
      N6EL=0
C                                 N3=1, LAYER OCCURING
C                                 N4, NUM
                  OF INTERVALS FOR THE LAYER
      N3=0
      N4=0
      DO 666 I=IBASE,I3
C                                 TEST FOR LAYER
      IF(DATA(5,I).LT.XMIN.OR.DATA(5,I).GE.XMAX)GOTO610
C                                 LAYER EXISTS
      N3=1
      N4=N4+1
      IF(I.NE.I3)GOTO666
C                                 LAYER MUST END
      IENDX=I2
      GOTO611
  610 IF(N3.EQ.0)GOTO666
C                                 LAYER ENDED
      IENDX=I
  611 IBEG=IENDX-N4
C                                 FIND BOTTOM
      HT=DATA(3,IBEG)
C                                 FIND THICKNESS
      TH=DATA(3,IENDX)-HT
C                                 FIND THE GRADIENT
      SUM=0.0
      IX=IENDX-1
      DO 612 II=IBEG,IX
  612 SUM=SUM+DATA(5,II)
      GR=SUM/FLOAT(N4)
C                                 INDEX FOR THE HEIGHT
      INDX1=HT/100.0+1.0
      IF(INDX1.LT.1)INDX1=1
      IF(INDX1.GT.51)INDX1=51
C                                 INDEX FOR THE THICKNESS
      INDX2=TH/25.0+1.0
      IF(INDX2.LT.1)INDX2=1
      IF(INDX2.LE.20)GOTO5041
      INDX2=(TH-499.0)/250.0+21.0
      IF(INDX2.GT.23)INDX2=23
C                                 INDEX FOR THE GRADIENT
 5041 GOTO(741,742,742,743),ISGN
  741 INDX3=IFIX((GR+1000.0)/35.6)+2
      IF(GR.LT.-1000.0)INDX3=1
```

```
      GOTO414
  742 INDX3=IFIX((GR-WW)/3.04)+1
      GOTO414
  743 INDX3=IFIX((GR-1000.0)/35.6)+1
      IF(GR.GT.1000.0)INDX3=25
C
C  INCREMENT LAYER COUNTERS WITH RESPECT TO THE SURFACE
C
C  ARRAY IST(I,J)     I - INDEX FOR STATIONS
                      J - COUNTERS FOR GIVEN
C  STATION     11-20 NUM SUR LAYERS     21-30 NUM EL LAYERS
C
  414 IF(N6SR.EQ.1)GOTO6668
      N6SR=1
      IF(HT+EL.LE.100.0)IST(IJKL,IIJ+10)=IST(IJKL,IIJ+10)+1
 6668 IF(N6EL.EQ.1)GOTO6669
      N6EL=1
      IF(HT+EL.GT.100.0)IST(IJKL,IIJ+20)=IST(IJKL,IIJ+20)+1
 6669 N3=0
      N4=0
C
C  FLAG IF FOUND A DUCTING LAYER
      IF(GR.LT.-157.0)IXFLAG=1
C
C  INCREMENT CHARACTERISTIC COUNTERS WITH RESPECT TO AREA
      DO 5146 KKX=1,INUMX
      IF(IAREA(KKX,1).EQ.999999)GOTO5046
      IF(LAT.LT.IAREA(KKX,1).OR.LAT.GT.IAREA(KKX,2))GOTO5146
      IF(LOG.LT.IAREA(KKX,3).OR.LOG.GT.IAREA(KKX,4))GOTO5146
 5046 ISUM(KKX,ISGN,INDX1)=ISUM(KKX,ISGN,INDX1)+1
      ISUM(KKX,ISGN,INDX2+51)=ISUM(KKX,ISGN,INDX2+51)+1
      ISUM(KKX,ISGN,INDX3+74)=ISUM(KKX,ISGN,INDX3+74)+1
 5146 CONTINUE
  666 CONTINUE
C
C  FLAG IF NOT FOUND DUCTING LAYER
      ISTA=IJKL
      IF(IXFLAG.EQ.0)ISTA=0
      CALL FREQX(DATA,IBASE,I3,LAT,LOG,ISTA)
      RETURN
      END
$IBFTC FREQ    NODECK
      SUBROUTINE FREQX(DATA,IBOT,ITOP,LAT,LOG,ISTA)
      COMMON INPUT,LCODE
      COMMON /X/ MON(13),INUM,IAREA(5,
                 4),INUMX,ISUM(4,4,99),IST(200,30),
     1NUMST,IXXI
      DIMENSION INPUT(316),LCODE(6,315)
      DIMENSION DATA(5,501)
```

```
C
C  CONVERT N PROFILE TO M PROFILE
      DO 1 I=IBOT,ITOP
      DATA(4,I)=DATA(4,I)+(DATA(3,I)/6370.0)*1.0E+3
     1 DATA(5,I)=DATA(5,I)+157.0
C
C  SET VARIABLES TO FIND MIN TRAPPING FREQ AND HEIGHT
      FRQ=999999
      HT=999999
C
C  IF NOT FOUND DUCTING LAYER DO NOT PROCESS, TEST FLAG
      IF(ISTA.EQ.0)GOTO1492
C
C  LOOK THROUGH PROFILE FROM BOTTOM
                 TO TOP FOR MIN IN M PROFILE
      IND1=IBOT+1
      IND2=ITOP-1
      DO 90 INDX=IND1,IND2
      IF(DATA(5,INDX).GE.0.0)GOTO90
      IF(DATA(5,INDX+1).LE.0.0)GOTO90
C
C  HAVE TOP OF LAYER, SET CONSTANTS
      XDT=DATA(3,INDX+1)
      XMT=DATA(4,INDX+1)
      XD2=XDT
      XM2=XMT
      ICNT=INDX-IBOT+1
      INDXX=INDX+1
      PI=0.0
C
C  FIND BOTTOM AND SUM PHASE INTEGRAL
      DO 91 IXI=1,ICNT
      INDXX=INDXX-1
      XD1=DATA(3,INDXX)
      XM1=DATA(4,INDXX)
      IF(XMT.GT.XM2.OR.XMT.LT.XM1)GOTO61
      XD1=XD2-(XD2-XD1)*(XM2-XMT)/(XM2-XM1)
      XM1=XMT
   61 S=(XM2-XM1)/(XD2-XD1)
      X1=SQRT((XM1-XMT+.001*S*(XD2-XD1))**3)
      X2=SQRT((XM1-XMT)**3)
      PI=PI+.942809*(X1-X2)/S
      IF(XD1.LE.0.0)GOTO92
      IF(XM1-XMT.EQ.0.0)GOTO92
      XD2=XD1
      XM2=XM1
   91 CONTINUE
      GOTO90
C
```

```
C  FOUND A LAYER
   92 CONTINUE
      XDB=XD1
      XMB=XM1
      FREQZ=(1.0/(4.0*PI))*300.0
      IF(XDB.LT.10.0)FREQZ=(3.0/(8.0*PI))*300.0
      IF(FREQZ.GT.FRQ)GOTO67
      FRQ=FREQZ
      HT=XDB
C
C  FLAG S DUCT AS -1 IN XDB        - GRADIENT AT SURFACE
C  FLAG ES DUCT AS -2 IN XDB       + GRADIENT AT SURFACE
   67 IF(XDB.NE.0.0)GOTO97
      XDB=-1
      IF(DATA(5,IBOT).GT.0.0)XDB=-2
C
C  INCREMENT COUNTERS
   97 CALL OUTX(2,XDB,FREQZ,LAT,LOG)
   90 CONTINUE
C
C  IF WANT TO PRINT HEADING, MIN FREQ
                AND HEIGHT REMOVE C FROM
C                 FOLLOWING CARDS
      WRITE(6,201)(IST(ISTA,I),I=1,4),
                  (INPUT(I),I=3,5),FRQ,HT
  201 FORMAT(7A6,2F9.2)
C
C  IF WANT TO PRINT PROFILE REMOVE C FROM FOLLOWING CARDS
C  PRES  TEM  DEW  HGT  M  M GRAD
C     DO 140 K=1,250
C     P1=(551-K)*2
C     P2=(251-K)*2
C 140 WRITE(6,141)P1,(DATA(I,K),I=1,
                  5),P2,(DATA(I,K+250),I=1,5)
C 141 FORMAT(6F9.2,5X,6F9.2)
C
C  WRITE ON UNIT 11 (BIN)
C  1ST WRITE  STAT NUM, LAT, LOG, EL,
                 HR, DAY, MONTH, BOTTOM, TOP
C  2ND WRITE  PROFILE OF TEM, DEW, HGT, M
C  3RD WRITE  MIN TRAPPING FREQ AND HGT
 1492 WRITE(11) INPUT(2),(INPUT(I),I=6,
                  8),(INPUT(I),I=3,5),IBOT,ITOP
      WRITE(11) ((DATA(I,K),I=1,4),K=1,500)
      WRITE(11) FRQ,HT
      RETURN
      END
$IBFTC OUTZ     NODECK
      SUBROUTINE OUTX(JFLAG,HGT,FREQ,LAT,LOG)
```

```
      COMMON /X/ MON(13),INUM,IAREA(5,
                 4),INUMX,ISUM(4,4,99),IST(200,30),
     1NUMST,IXXI
      DIMENSION JDATA(4,4,30)
C
C  JDATA(I,J,K)     I = GEOGRAPHIC AREA
C                   J = 1 FREQ FOR S DUCT
C                   J = 2 FREQ FOR ES DUCT
C                   J = 3 FREQ FOR E DUCT
C                   J = 4 HGT FOR E DUCT
C                   K = COUNTER DISTRIBUTION
C
      IF(JFLAG.GT.2)GOTO103
      GOTO(101,102),JFLAG
C
C  ZERO OUT AREA ARRAY
  101 DO 201 I=1,INUMX
      DO 201 J=1,4
      DO 201 K=1,30
  201 JDATA(I,J,K)=0
      RETURN
C
C  INCREMENT COUNTERS
C                   IFREQ   DEL   50        0 -   999
C                           DEL 1000     1000 - 10000
C                   IHGT    DEL  200        0 -  6000
  102 IF(HGT.LT.0.0)GOTO301
C
C  ELEVATED DUCTS
      IFREQ=FREQ/50.0+1.0
      IF(IFREQ.LE.20)GOTO502
      IFREQ=20.0+FREQ/1000.0
      IF(IFREQ.GT.30)IFREQ=30
  502 IHGT=HGT/200.0+1.0
      IF(IHGT.GT.30)IHGT=30
      DO 204 I=1,INUMX
      IF(IAREA(I,1).EQ.999999)GOTO203
      IF(LAT.LT.IAREA(I,1).OR.LAT.GT.IAREA(I,2))GOTO204
      IF(LOG.LT.IAREA(I,3).OR.LOG.GT.IAREA(I,4))GOTO204
  203 JDATA(I,3,IFREQ)=JDATA(I,3,IFREQ)+1
      JDATA(I,4,IHGT)=JDATA(I,4,IHGT)+1
  204 CONTINUE
      RETURN
C
C  SURFACE OR ELEVATED SURFACE DUCTS
  301 ITYPE=ABS(HGT)
      IFREQ=FREQ/50.0+1.0
      IF(IFREQ.LE.20)GOTO302
      IFREQ=20.0+FREQ/1000.0
```

```
      IF(IFREQ.GT.30)IFREQ=30
  302 DO 304 I=1,INUMX
      IF(IAREA(I,1).EQ.999999)GOTO303
      IF(LAT.LT.IAREA(I,1).OR.LAT.GT.IAREA(I,2))GOTO304
      IF(LOG.LT.IAREA(I,3).OR.LOG.GT.IAREA(I,4))GOTO304
  303 JDATA(I,ITYPE,IFREQ)=JDATA(I,ITYPE,IFREQ)+1
  304 CONTINUE
      RETURN
C
C  OUTPUT HEIGHT AND FREQUENCY DATA
  103 IMON=JFLAG-900
      WRITE(6,209)
  209 FORMAT(1H1,//,61H OUTPUT OF HEIGHT
                 AND FREQUENCY DISTRIBUTIONS FOR
     1 GIVEN AREAS)
      DO 208 I=1,INUMX
C
C  NORMALIZE FREQUENCY DISTRIBUTION
      DO 706 J=1,3
      DO 706 K=21,30
      IF(JDATA(I,J,K).EQ.0)GOTO706
      JDATA(I,J,K)=JDATA(I,J,K)/20+1
  706 CONTINUE
C
C  ON PRINTER
      WRITE(6,205)IMON,(IAREA(I,J),J=1,4)
  205 FORMAT(///,35H  MONTH   LAT1
                   LAT2   LOG1   LOG2,/,5I7)
      WRITE(6,206)(JDATA(I,1,K),K=1,30)
  206 FORMAT(/,10H S FREQ   ,30I4)
      WRITE(6,207)(JDATA(I,2,K),K=1,30)
  207 FORMAT(10H ES FREQ  ,30I4)
      WRITE(6,246)(JDATA(I,3,K),K=1,30)
  246 FORMAT(10H EL FREQ  ,30I4)
      WRITE(6,247)(JDATA(I,4,K),K=1,30)
  247 FORMAT(10H EL HGT   ,30I4)
C
C  ON UNIT 12   TO BE PRINTED OR PUNCHED
      ICNT=1
      WRITE(12,212)ICNT,I,IMON,(IAREA(I,J),J=1,4)
  212 FORMAT(3I2,4I6)
      DO 208 J=1,4
      IX2=0
      DO 208 K=1,2
      ICNT=ICNT+1
      IX1=IX2+1
      IX2=IX1+14
  208 WRITE(12,211)ICNT,I,IMON,(JDATA(I,J,L),L=IX1,IX2)
  211 FORMAT(3I2,15I4)
```

```
      RETURN
      END
$IBFTC OUT      NODECK
C  SUBROUTINE TO OUTPUT DATA AFTER EACH MONTH IS PROCESSED
C  IMON, MONTH OUTPUTING
C  UNIT 6 - LISTING          UNIT 12 - PUNCH CARDS
C
      SUBROUTINE OUTPUT(IMON)
      COMMON /X/ MON(13),INUM,IAREA(5,
                 4),INUMX,ISUM(4,4,99),IST(200,30),
     1NUMST,IXXI
      DIMENSION IXKX(5)
      DATA IMAK/6H 99999/
C
C  COMPUTE AVG SURFACE MEASUREMENTS FOR EACH STATION
      DO 8104 I=1,NUMST
      DO 8104 J=8,10
 8104 IST(I,J)=IST(I,J)/IST(I,7)
C
C  OUTPUT STATISTICS FOR EACH STATION
                 IN INCREASING STATION NUMBER ORDER
C
      WRITE(12,8001)
 8001 FORMAT(/////,23HMONTHLY STATION SUMMARY)
      WRITE(6,11)NUMST,IXXI
   11 FORMAT(1H1,///,24H MONTHLY STATION SUMMARY,10X,
     115H STATION COUNT ,I3,5X,21H NUMBER
                 OF SOUNDINGS ,I4,/)
      DO 8103 JJII=1,NUMST
      IMIN=IST(1,1)
      I=1
      DO 8105 JJ=2,NUMST
      IF(IST(JJ,1).LE.IMIN)GOTO8105
      IMIN=IST(JJ,1)
      I=JJ
 8105 CONTINUE
      WRITE(6,176)IMON,(IST(I,J),J=1,30)
  176 FORMAT(I3,4(1X,A6),6(1X,I6),10(1X,I3),/,73X,10(1X,I3))
      WRITE(12,178)IMON,(IST(I,J),J=1,10),IMON,IST(I,1),
     1(IST(I,J),J=11,30)
  178 FORMAT(2H 1,I2,4A6,6I6,/,2H 2,I2,A6,20I3)
 8103 IST(I,1)=IMAK
C
C  OUTPUT STATISTICS FOR EACH GEOGRAPHICAL AREA
C
      WRITE(12,8002)
 8002 FORMAT(/////,23HCHARACTERISTICS BY AREA)
      DO 98 IJ=1,INUMX
C
```

```
C  CALCULATE THE TOTAL NUMBER OF LAYERS FOR EACH DIVISION
      DO 4030 I=1,5
 4030 IXKX(I)=0
      DO 4032 I=1,4
      DO 4031 J=52,74
 4031 IXKX(I)=IXKX(I)+ISUM(IJ,I,J)
 4032 IXKX(5)=IXKX(5)+IXKX(I)
      IWXX=1
      WRITE(6,2)IMON,(IAREA(IJ,J),J=1,4),IXKX(5)
    2 FORMAT(1H1,///,25H  CHARACTERISTICS
     *          BY AREA,/,7H  MONTH,3X,
     *  14HLAT1,3X,4HLAT2,3X,4HLONG1,3X,4HLONG2,/,5(1X,I6),5X,
     *  22HTOTAL NUMBER OF LAYERS,I5)
      WRITE(12,12)IWXX,IJ,IMON,(IAREA(IJ,J),J=1,4)
   12 FORMAT(3I2,4I6)
      DO 98 KK=1,4
      IX2=0
      DO 198 KKK=1,6
      IWXX=IWXX+1
      IX1=IX2+1
      IX2=IX1+16
      IF(IX2.GT.99)IX2=99
  198 WRITE(12,14)IWXX,IJ,IMON,(ISUM(IJ,KK,IK),IK=IX1,IX2)
   14 FORMAT(3I2,17I4)
      GOTO(610,611,612,613),KK
  610 WRITE(6,1610)IXKX(1)
 1610 FORMAT(/,18H GRADIENTS LT -150,
     *          22X,16HNUMBER OF LAYERS,I5)
      GOTO98
  611 WRITE(6,1611)IXKX(2)
 1611 FORMAT(/,30H GRADIENTS GE -150,
     *           AND LE -75,11X,16HNUMBER OF LAYERS
     *1,I5)
      GOTO98
  612 WRITE(6,1612)IXKX(3)
 1612 FORMAT(/,28H GRADIENTS GE 75,
     *          AND LE 150,13X,16HNUMBER OF LAYERS,
     *1I5)
      GOTO98
  613 WRITE(6,1613)IXKX(4)
 1613 FORMAT(/,17H GRADIENTS GT 150,
     *          23X,16HNUMBER OF LAYERS,I5)
   98 WRITE(6,702)(ISUM(IJ,KK,IK),IK=1,99)
  702 FORMAT(/,4H HGT,20(1X,I4),/,4X,
     *          20(1X,I4),/,4X,11(1X,I4),/,4H THK,
     *  120(1X,I4),/,4X,3(1X,I4),/,4H GRA,
     *          20(1X,I4),/,4X,5(1X,I4))
C
C  OUTPUT FREQ DATA BY AREA
```

```
      WRITE(12,8003)
 8003 FORMAT(//////,22HFREQUENCY DATA BY AREA)
      IXMON=IMON+900
      CALL OUTX(IXMON,0.,0.,0.,0.)
      RETURN
      END
$IBFTC HGT     NODECK
C  FUNCTION HEIGH COMPUTES THE HEIGHT BETWEEN TWO SETS OF
C  METEOROLOGICAL DATA
C
      FUNCTION HEIGH(P1,P2,DEG1,DEG2,DEW1,DEW2)
      DATA A,B,C/25.0578498,-3009.47384,-5.43916634/
      RATIO1=A+B/(DEW1+273.0)+C*ALOG10(DEW1+273.0)
      RATIO2=A+B/(DEW2+273.0)+C*ALOG10(DEW2+273.0)
      WM=(10.0**RATIO1/P1+10.0**RATIO2/P2)/2.0
      HEIGH=18400.0*ALOG10(P1/P2)
     1*(1.0+(((DEG1+DEG2)/2.0)/273.0))/(1.0-0.378*WM)
      RETURN
      END
$IBFTC INDX    NODECK
C  FUNCTION XIND COMPUTES THE REFRACTIVE
                 INDEX GIVEN PRESSURE,
C  TEMPERATURE, AND DEW POINT
C
      FUNCTION XIND(P,TEM,DEW)
      DATA A,B,C/25.0578498,-3009.47384,-5.43916634/
      RATIO=A+B/(DEW+273.0)+C*ALOG10(DEW+273.0)
      XIND=(77.6/(TEM+273.0))
     1*(P+(4810.0*(10.0**RATIO))/(TEM+273.0))
      RETURN
      END
$IBMAP HELP    NODECK
INPUT  FILE    ,A(1),BLK=316,BCD,DEFER
KPUT   FILE    ,A(2),BLK=316,BCD,DEFER
OPEN1  SAVE
       TSX     .CLOSE,4
       PTW     KPUT
       TSX     .OPEN,4
       PZE     INPUT
       RETURN  OPEN1
OPEN2  SAVE
       TSX     .CLOSE,4
       PTW     INPUT
       TSX     .OPEN,4
       PZE     KPUT
       RETURN  OPEN2
IN     SAVE
       CLA*    5,4
       SXA     A,4
```

```
          TPL     *+7
          TSX     .READ,4
          PZE     INPUT
          PZE     E0F,,*-2
          I0RT    BL0CK,,**
          LXD     *-1,4
          TRA     **+6
          TSX     .READ,4
          PZE     KPUT
          PZE     E0F,,*-2
          I0RT    BL0CK,,**
          LXD     *-1,4
          PXA     ,4
A         AXT     **,4
          ST0*    3,4
          STZ*    4,4
          RETURN  IN
E0F       XEC     A
          CLA     =1
          ST0*    4,4
          RETURN  IN
          C0NTRL  //
BL0CK     C0MM0N  316
          END
$IBMAP    DEC0DE  N0DECK
DEC0DE    SAVE    2,1,I
          CAL     4,4
          ADD     =5760
          STA     ST0RE
          CAL*    5,4
          STA     *+3
          ADD     3,4
          STA     LMQ
          AXT     **,4
          AXT     5760,2
L00P2     AXT     6,1
LMQ       LDQ     **,4
L00P1     CLA     =0
          LGL     6
ST0RE     ST0     **,2
          TXI     *+1,2,-1
          TIX     L00P1,1,1
          TIX     L00P2,4,1
          RETURN  DEC0DE
          END
$DATA
```

```
$IBJOB          MAP
$USE            BLKPAR(ZPARAN),BLKPAR(ZPARAM)
$USE            BLKTAP(ZTPDNN),BLKTAP(ZTPDNT),BLKTAP(ZTPDHL)
$USE            BLKTAP(ZNFPL),BLKTAP(ZTPDMP)
$USE            XBLKS(ZHEIGH),XBLKS(PATOUT),
                  XBLKS(INPT),XBLKS(ZTAB)
$USE            XBLKS(ZLINE),XBLKS(WETOUT),XBLKS(REFOUT)
$IBFTC XBLKS    DECK
C       BLOCK DATA TO ENSURE THAT COMMONS
                  ALL HAVE PROPER SIZE.
        BLOCK DATA
        COMMON /ZHEIGH/ HEIGHT(5)
        COMMON /PATOUT/ PAT(10)
        COMMON /INPT/ YINPT(15)
         COMMON /ZTAB/ TAB(402)
        COMMON /ZLINE/ LINE(200)
        COMMON /WETOUT/ WET(4)
        COMMON /REFOUT/ REF(6)
        END
$IBFTC BLKTAP  DECK
        BLOCK DATA
C       TAPE DESCRIPTION
        COMMON /ZTPDNN/ NMISS,NAMES(20)
        COMMON /ZTPDNT/NTMPER(20)
        COMMON /ZTPDMP/MAPT(13)
        COMMON /ZTPDHL/ISPEC(2,20)
        COMMON /ZNFPL/NFPL
        DATA NMISS,(NAMES(I),I=1,14) /14,
       1 6HCAR001,6HCAR002,6HCAR003,6HCAR004,
                  6HCAR005,6HCAR006,6HCAR007,
       2 6HCAR008,6HCAR009,6HCAR010,6HCAR011,
                  6HCAR012,6HCAR013,6HCAR014/
        DATA (NTMPER(I),I=1,14) /14*1/
        DATA((ISPEC(I,J),I=1,2),J=1,14) /
       X 6,9, 15,18, 10,15, 14,17, 12,
                  16, 12,16, 13,16, 9,12, 6,7,
       X  11,12, 16,18, 2,6, 8,10, 6,10  /
        DATA (MAPT(I),I=1,13) /1,2,3,4,5,6,8,7,9,10,11,2,12/
        DATA NFPL /12/
        END
```

```
$IBFTC XAIDA   DECK
C    AIRCRAFT DATA REDUCTION DRIVER PROGRAM, REFCOL-INPUT
C
      SUBROUTINE AIDA
      COMMON /ZNFLT/NFLT
      COMMON /ZPARAM/DUM(25),PROCS,DUMP
      COMMON /INPT/PAR,LST
      LOGICAL PROCS
      LOGICAL DUMP
      LOGICAL PAR
      LOGICAL LST
    1 FORMAT(1H1)
      NFLT = 0
  100 NFLT = NFLT+1
      CALL PINT1
      CALL POUT1
      IF(DUMP) WRITE(6, 1)
  150 CALL INPUT
      IF (PROCS) CALL REFCOL
      IF (.NOT.LST) GO TO 150
      GO TO 100
      END
```

```
$IBFTC XPINT1  DECK
      SUBR0UTINE PINT1
C THIS SUBR0UTINE INPUTS THE PARAMETERS CARDS
C IT ASSIGNS THE VALUE 0F THE PARAMETER
                  ACC0RDING T0 THE TYPE
C THE NAME 0F THE PARAMETER ISS USED
                  T0 FIND THE TYPE AND 0FFSET
C IN THE TABLE PARAN.
C
      C0MM0N /ZPARAN/ NPAR, PARAN(2,1)
      C0MM0N /ZPARAM/ PARAM(1)
      INTEGER PARAN,ALPH,C0M(10),IPARAM(1)
      INTEGER STP,TR,FAL
      L0GICAL LPARAM(1)
      EQUIVALENCE ( PARAM(1),IPARAM(1),LPARAM(1) )
      DATA ND,TR,FAL /5H*END*,1HT,1HF/
      DATA STP/6H*ST0P*      /
      WRITE(6,902)
  100 READ(5,900) ALPH,VAL,C0M
      WRITE(6,901) ALPH,VAL,C0M
      IF(ALPH .EQ. ND) RETURN
      IF( ALPH .EQ. STP) ST0P
      D0 150 I=1,NPAR
      IX=I
      IF(ALPH .EQ. PARAN(1,I)) G0 T0 200
  150 C0NTINUE
      WRITE(6,903)
      G0 T0 100
  200 N=PARAN(2,IX)
      G0 T0(300,350,400,450,500), N
C D0 ASSIGNMENT ACC0RDING T0 THE TYPE 0F PARAMETER
C
C FL0ATING P0INT PARAMETER
  300 PARAM(IX)=VAL
      G0 T0 100
C FIXED P0INT PARAMETER
  350 IPARAM(IX)=VAL
      G0 T0 100
C L0GICAL PARAMETER
  400 IF(C0M(1) .EQ. TR) LPARAM(IX)=.TRUE.
      IF(C0M(1) .EQ. FAL) LPARAM(IX)=.FALSE.
      IF( C0M(1).NE.TR .AND. C0M(1).NE.FAL ) WRITE(6,904)
      G0 T0 100
C ALPHANUMERIC PARAMETER
  450 IPARAM(IX)=C0M(1)
      G0 T0 100
C TIME PARAMERER
  500 ITIME=VAL
      IHR=ITIME/10000
```

```
      IMIN= MOD (ITIME/100,100)
      ISEC = MOD (ITIME,100)
      PARAM(IX)=ISEC+60*(IMIN+60*IHR)
      GO TO 100
  900 FORMAT(A6,2X,F10.0,10A6)
  901 FORMAT(1X,A6,2X,E15.5,1X,10A6)
  902 FORMAT(1H1,1X,4HNAME,14X,5HVALUE,7X,8HCOMMENTS  )
  903 FORMAT(33H UNRECOGNIZED NAME. CARD IGNORED. )
  904 FORMAT(29H ILLEGAL VALUE. CARD IGNORED.)
      END
```

```
$IBFTC XHGT    DECK
C         HEIGHT    BEEBE + SULLIVAN    2.1
      SUBROUTINE HEIGHT(I)
C     I GE 1 IF NOT FIRST TIME THROUGH ROUTINE FOR A SPIRAL
C     RADIUS = RADIUS OF EARTH
C     ZS = HEIGHT OF REFERENCE SURFACE ABOVE SEA LEVEL
C     PR = PRESSURE, FN = REFRACTIVE
                  INDEX, FKF = TEMPERATURE,EF = VAPOR
C     Z = GEOPOTENTIAL HEIGHT, R = SEMIMINOR
                  AXIS,A= SEMIMAJOR AXIS
      COMMON /ZPARAM/ZS,DUM(21),RADIUS,R,A,DUM2(30),ZOFS1
      COMMON /ZHEIGH/FN,EF,Z,RHO,RMF
      COMMON /PATOUT/PR,DUM1(5),FKF
      IF (I.GE.1) GO TO 1
      Z = ZOFS1 + ZS
      FKS1 = FKF*(1.0 + 0.388 * EF/PR)
      GO TO 2
    1 FKS2 = FKF*(1.0 + 0.388 * EF/PR)
      VAL = ALOG (OLDPR / PR)
      DELPSI = 14.645 * (FKS1 + FKS2) * VAL
      DELZ = DELPSI *(R/A) * (1.0 +
                  2.0 * ZOLD / R + DELPSI / A )
      Z = ZOLD + DELZ
      FKS1 = FKS2
    2 RHO = Z / RADIUS
      RMF = FN*(1.0 + RHO)*0.000001 + RHO
      ZOLD = Z
      OLDPR = PR
      RETURN
      END
```

```
$IBFTC XINPUT  DECK
C
      SUBROUTINE INPUT
C   INPUT COMMONS
      COMMON /ZNFLT/NFLT
      COMMON /ZPARAM/DUM(47),MISID,TSTART,TSTOP
C   TAPE DESCRIPTION COMMONS
      COMMON /ZTPDNN/NMISS,NAMES(1)          /ZTPDNT/NTMPER(1)
     1       /ZTPDMP/MAPT(13)               /ZTPDHL/ISPEC(2,1)
C   OUTPUT COMMON
      COMMON /INPT/PAR,LST,X(13)
C   COMMUNICATION WITH LOWER SUBROUTINES
      COMMON /ZFLTIM/IH1,IM1,IS1,IH2,IM2,IS2
      COMMON /ZNWMIS/NWMIS                   /ZMISNO/MISNO
     1       /ZMISSR/MISSR                   /ZISPTR/ISPTR
     2       /ZTAB/P,N,TAB(1)                /ZEOM/EOM
     3       /ZRTIME/RTIME                   /ZIREL/IREL
     4       /ZLINE/LINE(1)
      COMMON /ZCERR/CERR
      LOGICAL NWMIS,EOM,P,PAR,LST,MSL
      LOGICAL CERR
      LOGICAL LOGCOM
      DATA LFLT,LMIS /0,0/
C   FORMATS
    1 FORMAT(46H NO SUCH MISSION ID
               ON TAPE - FLIGHT IGNORED.  )
    2 FORMAT(48H MISSION REQUESTS OUT
               OF SORT - FLIGHT IGNORED.  )
C   IS THIS A NEW FLIGHT
      IF (NFLT .EQ. LFLT) GO TO 1000
      LFLT = NFLT
C  YES, INITIALIZE IF NFLT = 1
      IF (NFLT .NE. 1) GO TO 105
      NWMIS = .TRUE.
      MISNO = 1
C   FIND NO. OF REQUESTED MISSION
  105 ISPTS = 1
      DO 110 MISS=1,NMISS
      MISSR=MISS
      IF(MISID .EQ. NAMES(MISSR)) GO TO 120
  110 ISPTS = ISPTS+NTMPER(MISSR)
C   CANNOT FIND MISSION WITH PROPER ID
      WRITE(6,1)
      GO TO 2010
C   IS THE MISSION THE SAME AS THE LAST (ERROR IF LESS)
  120 IF (MISSR .GE. LMIS) GO TO 130
      WRITE(6,2)
      GO TO 2010
  130 MSL = MISSR .EQ. LMIS
```

```
      IF (MSL) G0 T0 200
      LMIS = MISSR
C   UPDATE MISSI0N-ASS0C. C0NSTANTS
      ISPTR = ISPTS
      IREL = ISPEC(1,ISPTR)
C   IF THE TAPE HAS T0 BE M0VED, M0VE
                  IT AND UPDATE PHYSICAL TAPE
C    P0SITI0N INDICAT0RS
      NMS = MISSR-MISN0
      E0M = .FALSE.
      IF (NMS .LE. 0) G0 T0 200
      D0 150 I = 1,NMS
  145 CALL SFDATP
      CALL RDATP
      IF (N .NE. 0) G0 T0 145
  150 C0NTINUE
      MISN0 = MISSR
      NWMIS = .TRUE.
C   UPDATE FLIGHT C0NSTANTS
  200 IH1 = TSTART/3600.
      IM1 = AM0D(TSTART,3600.)/60.
      IS1 = AM0D(TSTART,60.)
      IH2 = TST0P/3600.
      IM2 = AM0D(TST0P,3600.)/60.
      IS2 = AM0D(TST0P,60.)
      IH1R = M0D(IH1+24-IREL,24)
      IH2R = M0D(IH2+24-IREL,24)
      RQRST = 3600*IH1R + 60*IM1 + IS1
      RQRET = 3600*IH2R + 60*IM2 + IS2
C   IF SAME MISSI0N, SKIP 1ST READ
      IF (MSL) G0 T0 310
C   FIND FIRST LINE
  300 CALL RDLINE
  310 IF (E0M) G0 T0 2010
      IF (RTIME .LT. RQRST) G0 T0 300
C   0UTPUT A LINE
 1000 PAR = CERR
      X(1) = AM0D(RTIME+3600.*FL0AT(IREL),86400.)
      D0 1100 I = 2,13
      K1 = 4*(MAPT(I)-1) + 1
      K4 = K1+3
      D0 1010 J = K1,K4
      IF (LINE(J) .GT. 9) G0 T0 1020
 1010 C0NTINUE
      X(I) = 1000*LINE(K1)+100*LINE(K1+
                 1)+10*LINE(K1+2)+LINE(K1+3)
      G0 T0 1100
 1020 PAR = .TRUE.
 1100 C0NTINUE
```

```
C   READ ANEW
      CALL RDLINE
      LST = EOM .OR. RTIME.GT.RQRET
      RETURN
C   FAILURE EXIT
 2010 DO 2020 I = 1,13
 2020 X(I) = 0.
      PAR = .TRUE.
      LST = .TRUE.
      RETURN
      END
```

```
C      ROUTINE COMPUTES PRESSURE,AIR SPEED AND TEMPERATURE
       SUBROUTINE PAT
       COMMON /INPT/ P,L,XTIME,XR1,XR2,
                     XR3,XALT,XEVENT,XSPEED,XPRES,XKS4T
      1,XEKT,XRH,XR4,XVXT
       COMMON /ZPARAM/ ZS,RFS1,RFV1,RNM1,
                     RKP1,ANDF1,ANWF1,ACMRVP,
      1 CORMR,CORVP,CORIN,ITPROB,IHUM,
                     IRSCT,PUNCH,KPAR,BETA1,BETA2,
      2 BETA3,BETA4,BETA5,ALPHA,RADIUS,R,A,PROCS,DUMP,
      3 PVMIN,PVMAX,PMIN,PMAX,SVMIN,SVMAX,
                     SMIN,SMAX,T4VMIN,T4VMAX,
      4T4MIN,T4MAX,
      5 EKVMIN,EKVMAX,EKMIN,EKMAX,VXVMIN,VXVMAX,VXMIN,VXMAX,
      6MISSID,TSTART,TSTOP,CPRES,CSPEED,
                     CKS4T,CEKT,CVXT,ZOFS1,CHKFC
       COMMON /PATOUT/ PRES,SPEED,S,TKS4,
                     TEK,TVTX,FKF,TF,PTEMP,FNDF
       TLIN(X,A,B,Y,Z) = (X-A)*(Z-Y)/(B-A)+Y
       T73 = 273.16
       ONE = 1.0
       DPDN = 1.
       PMK4 = TLIN(XPRES,PVMIN,PVMAX,PMIN,PMAX) + CPRES
       PRES = PMK4 + DPDN
       SPEED = TLIN(XSPEED,SVMIN,SVMAX,SMIN,SMAX) + CSPEED
       S = SPEED**2/PRES
       TKS4 = TLIN(XKS4T,T4VMIN,T4VMAX,T4MIN,T4MAX) + CKS4T
       TEK = TLIN(XEKT,EKVMIN,EKVMAX,EKMIN,EKMAX) + CEKT
       TVTX = TLIN(XVXT,VXVMIN,VXVMAX,VXMIN,VXMAX) + CVXT
       GO TO (1,2,3),ITPROB
     1 FKF = (TKS4 + T73    )/(ONE+ BETA1 * S)
       GO TO 4
     2 FKF = (TEK +  T73   )/(ONE+ BETA2 * S)
       GO TO 4
     3 FKF = (TVTX + T73)/(ONE + BETA3 * S)
     4 TF = FKF - T73
       IF (PRES) 5,5,6
     5 PTEMP = 0.
       GO TO 7
     6 PTEMP = FKF*(1000.0/PRES)**(2./7.) - T73
     7 FNDF = 77.6*PRES/FKF
       RETURN
       END
```

```
$IBFTC XPOUT1  DECK
C   PARAMETER PRINT I
C
      SUBROUTINE POUT1
      COMMON /ZPARAN/NPAR,PARAN(2,1)        /ZPARAM/PARAM(1)
      INTEGER PARAN
      DIMENSION NAMES(5),VALUES(5),FORMS(3,
     5),ITIM(15),FORM(3)
      EQUIVALENCE (ITIM,VALUES)
      DATA FORMS(1,1)          /24H(5(1XF19.9))
     /
      DATA FORMS(1,2)          /24H(5(1XI9,
     10X))                      /
      DATA FORMS(1,3)          /24H(5(9XL1,
     10X))                      /
      DATA FORMS(1,4)          /24H(5(6XA6,
     8X))                       /
      DATA FORMS(1,5)          /24H(5(I6,
     2(1H.I2)7X))                /
    1 FORMAT(1H1,50X,28H= CURRENT PARAMETER VALUES = )
    2 FORMAT(/5(1X,1H*,5X,A6,6X,1H*))
      WRITE(6,1)
      DO 100 ITYPE = 1,5
      NVAL = 0
      DO 10 I = 1,3
   10 FORM(I) = FORMS(I,ITYPE)
      DO 99 I = 1,NPAR
      IF (ITYPE.NE.PARAN(2,I)) GO TO 80
      NVAL = NVAL + 1
      NAMES(NVAL) = PARAN(1,I)
      IF (ITYPE .EQ. 5) GO TO 30
      VALUES(NVAL) = PARAM(I)
      GO TO 80
   30 V = PARAM(I)
      NT = 3*NVAL-2
      ITIM(NT) = V/3600.
      ITIM(NT+1) = AMOD(V,3600.)/60.
      ITIM(NT+2) = AMOD(V,60.)
   80 IF (.NOT.(NVAL .EQ. 5  .OR. (I
     .EQ. NPAR .AND. NVAL .GT. 0)))
     1    GO TO 99
      WRITE(6,2)  (NAMES(J),J=1,NVAL)
      IF (ITYPE .EQ. 5) NVAL = 3*NVAL
      WRITE(6,FORM) (ITIM(J),J=1,NVAL)
      NVAL = 0
   99 CONTINUE
  100 CONTINUE
      RETURN
      END
```

```
$IBFTC XRDLIN  DECK
```

```
C   READ A LINE OF PAPER TAPE DATA
C
      SUBROUTINE RDLINE
      COMMON/ZTPDHL/ISPEC(2,1)                /ZISPTR/ISPTR
     1       /ZLINE/LINE(200)                /ZTPDMP/MAPT(1)
     2       /ZRTIME/RTIME
     4       /ZIREL/IREL                      /ZEOM/EOM
     5       /ZMISSR/MISSR
      COMMON /ZMISNO/ MISNO
      COMMON /ZPARAM/DUM1(26),DUMP,DUM2(29),CHKFC
      COMMON /ZNFPL/NFPL
      COMMON /ZCERR/CERR
      DIMENSION CLIST(12),CHAR(200)
      LOGICAL EOM,DUMP
      LOGICAL CHKFC,CERR
      DATA (CLIST(I),I=1,12) /1HO,1H1,
                  1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,
     X 1H.,1H*  /
      DATA LMIS /0/
    1 FORMAT (26(1X,4A1)/(5X,120A1))
      IF (MISSR .EQ. LMIS) GO TO 200
C   INITIALIZATION EACH MISSION
      LMIS = MISSR
      KK = 0
      K1T = 4*(MAPT(1)-1)+1
      KRH = 0
      PTL = 0.
      ITSPH = MOD(ISPEC(2,ISPTR)+24-IREL,24)
      LEGNC = 4*NFPL + 1
  200 DO 299 I = 1,200
      KK = KK+1
      KR = KHAR(KK)
      IF(EOM) GO TO 400
      LINE(I) = KR
      CHAR(I) = CLIST(KR+1)
      IF (KR .EQ. 10) GO TO 400
  299 CONTINUE
      I = 200
  300 KK = KK+1
      KR = KHAR(KK)
      IF(EOM) GO TO 400
      IF (KR .NE. 10) GO TO 300
C   EOL CHARACTER REACHED
  400 IF(DUMP) WRITE(6,1) (CHAR(J),J=1,I)
      IF(EOM) MISNO=MISNO+1
      IF (EOM) RETURN
      CERR = (CHKFC .AND. I .NE. LEGNC) .OR.
     1  LINE(K1T  ) .GT. 5 .OR. LINE(K1T+1) .GT. 9 .OR.
     2  LINE(K1T+2) .GT. 5 .OR. LINE(K1T+3) .GT. 9
```

```
      IF (.NOT. CERR) GO TO 450
      PT = PTL
      GO TO 500
  450 PT = 60*(10*LINE(K1T)+LINE(K1T+
     1)) + 10*LINE(K1T+2) + LINE(K1T+3)
      IF (PT .GE. PTL) GO TO 500
      KRH = KRH+1
      IF (KRH .LE. ITSPH) GO TO 500
      ISPTR = ISPTR+1
      KRH = MOD(ISPEC(1,ISPTR)+24-IREL,24)
      ITSPH = MOD(ISPEC(2,ISPTR)+24-IREL,24)
  500 RTIME = 3600.*FLOAT(KRH) + PT
      PTL = PT
      RETURN
      END
```

```
      SUBROUTINE REFCOL
      COMMON /ADATA/ EH2O(1000)
      COMMON /INPT/ PAR,LAST,XTIME,XR1,
     1             XR2,XR3,XALT,XEVENT,XSPEED,XPRES,
     1XKS4T,XEKT,XRH,XR4,XVXT
      COMMON /ZPARAM/ ZS,RFS1,RFV1,RNM1,
     1             RKP1,ANDF1,ANWF1,ACMRVP,
     1CORMR,CORVP,CORIN,ITPROB,IHUM,
     1             IRSCT,PUNCH,KPAR,BETA1,BETA2,BETA3,
     2BETA4,BETA5,ALPHA,RADIUS,R,A,PROCS,DUMP
      COMMON /PATOUT/ PRES,SPEED,S,TKS4,
     1             TEK,TVTX,FKF,TF,PTEMP,FNDF
      COMMON /WETOUT/ ARF,AEF,ANWF,ANF
      COMMON /REFOUT/ RDNM,RNM,RNWF,REF,RRF,RNF
      COMMON /ZHEIGH/FNF,EF,Z,RHO,RMF
      DIMENSION MRDNG(50),ZSPEED(50),
     1             ZPR(50),ZTKS4(50),ZTEK(50)
      DIMENSION ZTVTX(50),ZDELN(50),
     1             ZN(50),ZFNDF(50),ZFNWF(50),ZTIME(50)
      DIMENSION IIVENT(50),ZFNF(50),
     1             ZPINDX(50),ZZ(50),ZALT(50),ZPRES(50)
      DIMENSION ZTF(50),ZPTEMP(50),ZMIXR(50),
     1             ZVAPOR(50),ZRMF(50)
      DIMENSION IPAR(50)
      DIMENSION ZNF(50)
      LOGICAL PAR,LAST,PUNCH
      LOGICAL PROCS,DUMP
      INTEGER ZTIME
      DATA KOUNT/0/,II/0/
      DATA ISTAR/1H*/,IBLANK/1H /
      IF (KPAR) 5,5,1
    5 IF (.NOT.PAR) GO TO 1
      IF (LAST.AND.(II.GE.1)) GO TO 501
      IF (LAST) GO TO 520
      RETURN
    1 CALL PAT
      CALL WET
      IF (RKP1) 2,2,3
    2 IHUM = 1
    3 IF (IHUM.EQ.1) GO TO 110
      GO TO (50,50,50,55),IRSCT
   50 IF (RFS1) 51,51,60
   51 IHUM = 1
      GO TO 110
   55 IF (RFV1) 56,56,60
   56 IHUM = 1
      GO TO 110
   60 CALL REFCT
      FNF= RNF
```

```
      RF2 = RRF
      EF = REF
      GO TO 115
  110 FNF = ANF
      RF2 = ARF
      EF = AEF
      RNM = 0.
      RDNM = 0.
      RNWF = 0.
  115 CALL HEIGHT(KOUNT)
      ZPRT = Z - ZS
      IF (Z.LT.ACMRVP) GO TO 120
      FNF = FNF + CORIN
      RF2 = RF2 + CORMR
      EF = EF + CORVP
  120 ALT = 1.499 * XALT
      ITIME = XTIME
      ISEC = MOD(ITIME,60)
      ITIME1 = ITIME/60
      IMIN = MOD(ITIME1,60)
      IHRS = ITIME/3600
      TIMEX = 10000*IHRS + 100*IMIN + ISEC
      IVENT = XEVENT/100.
      IF (PRES) 200,200,201
  200 PINDEX = 0.
      GO TO 202
  201 PINDEX = FNF*(1000./PRES)**0.714
  202 KOUNT = KOUNT + 1
      IF(PUNCH) WRITE(1,10) KOUNT,Z,
                FNF,RMF,TF,PTEMP,EF,PRES,RF2
      II = II + 1
      MRDNG(II)= KOUNT
      ZSPEED(II) = SPEED
      ZPR(II) = PRES - 1.
      ZTKS4(II) = TKS4
      ZTEK(II) = TEK
      ZTVTX(II)= TVTX
      ZDELN(II)= RDNM
      ZN(II)= RNM
      ZFNDF(II) = FNDF
      ZFNWF(II) = RNWF
      ZTIME(II) = TIMEX
      IIVENT(II) = IVENT
      ZFNF(II) = FNF
      ZPINDX(II) = PINDEX
      ZZ(II) = ZPRT
      ZALT(II) = ALT
      ZPRES(II) = PRES
      ZTF(II) = TF
```

```
      ZPTEMP(II) = PTEMP
      ZMIXR(II) = RF2
      ZVAPOR(II) = EF
      ZRMF(II) = RMF
      IF (PAR) GO TO 600
      GO TO 610
  600 IPAR(II) = ISTAR
      GO TO 500
  610 IPAR(II) = IBLANK
  500 IF (II .NE. 50 .AND. (.NOT.LAST)) RETURN
  501 WRITE(6,26)
      WRITE(6,20)
      WRITE(6,21)
      WRITE(6,22)
  502 DO 510 K = 1,II
  510 WRITE(6,11) MRDNG(K),IPAR(K),ZSPEED(K),
                  ZPR(K),ZTKS4(K),ZTEK(K),
     1ZTVTX(K),ZDELN(K),ZN(K),ZFNDF(K),ZFNWF(K)
      WRITE(6,26)
      WRITE(6,23)
      WRITE(6,24)
      WRITE(6,25)
  503 DO 515 K = 1,II
  515 WRITE(6,12) MRDNG(K),IPAR(K),ZTIME(K),
                  IIVENT(K),ZFNF(K),ZPINDX(K),
     1 ZZ(K),ZALT(K),ZPRES(K),ZTF(K),
                  ZPTEMP(K),ZMIXR(K),ZVAPOR(K),
     2ZRMF(K)
      IF(DUMP) WRITE(6,26)
      IF (.NOT.LAST) GO TO 525
  520 KOUNT = 0
      IF(PUNCH) ENDFILE 1
  525 II = 0
      RETURN
   10 FORMAT(I6,2F7.1,6PF7.1,0P4F7.1,3PF7.1)
   11 FORMAT (5XI4,A1,7XF5.1,8XF6.1,7(8XF5.1))
   20 FORMAT(4X,7HREADING,5X,8HAIRSPEED,
                  5X,8HPRESSURE,17X,11HTEMPERATURE
     X,20X,13HREFRACTOMETER)
   21 FORMAT(17X,5HKNOTS,10X,3HMB.,10X,
                  3HKS4,7X,9HPLAT.WIRE,5X6HVORTEX,
     X 7X7HDELTA N,9X1HM,10X5HN DRY,8X5HN WET)
   22 FORMAT(44X5HDEG.C,8X5HDEG.C,8X5HDEG.C)
   12 FORMAT (6XI4,A1,3XI6,4XI1,4XF5.1,
                  4XF5.1,4XF7.1,4XF7.1,4XF6.1,4X
     1F5.1,4XF5.1,4X3PF5.2,4X0PF5.2,4X6PF8.1)
   23 FORMAT(4X7HREADING,4X4HTIME,3X5HEVENT,
                  4X1HN,8X1HK,4X10HGEO.HEIGHT,
     X 2X9HALTIMETER,2X8HPRESSURE,3X5HTEMP.,
                  2X9HPOT.TEMP.,1X6HMIXING,
```

```
     X 4X5HVAPOR,8X1HM)
  24 FORMAT(47X6HMETERS,5X6HMETERS,
                  7X3HMB.,5X5HDEG.C,4X5HDEG.C,4X
     X 5HRATIO,3X8HPRESSURE )
  25 FORMAT(98X4HG/KG /)
  26 FORMAT (1H1)
     END
```

```
$IBFTC XREFCT  DECK
      SUBROUTINE REFCT
      COMMON /INPT/ PAR,LAST,XTIME,XR1,
                    XR2,XR3,XALT,XEVENT,XSPEED,XPRES,
     1XKS4T,XEKT,XRH,XR4,XVXT
      COMMON /ZPARAM/ ZS,RFS1,RFV1,RNM1,
                    RKP1,ANDF1,ANWF1,ACMRVP,
     1CORMR,CORVP,CORIN,ITPROB,IHUM,
                    IRSCT,PUNCH,KPAR,BETA1,BETA2,BETA3,
     2BETA4,BETA5,ALPHA,RADIUS,R,A
      COMMON /PATOUT/ PRES,SPEED,S,TKS4,
                    TEK,TVTX,FKF,TF,PTEMP,FNDF
      COMMON /WETOUT/ ARF,AEF,ANWF,ANF
      COMMON /REFOUT/ RDNM,RNM,RNWF,REF,RRF,RNF
      CON1 = 1.0 + (BETA5*S*1.4/.4)
      CON2 = 1.0 +BETA5 * S
      RKP = FKF * (1. + BETA4 * S)
      GO TO (1,2,3,4), IRSCT
    1 XXX = XR1
      GO TO 5
    2 XXX = XR2
      GO TO 5
    3 XXX = XR3
      GO TO 5
    4 RDELN = (XR4 - RFV1)/9.245
      GO TO 6
    5 RDELN = (XXX - RFS1)/9.245
    6 RDNM = RDELN + ALPHA*(RKP-RKP1)
      RNM = RNM1 - RDNM
      RNDM = (FNDF*CON1)/CON2
      RNWM = RNM - RNDM
      RNWF = RNWM * (CON2**2/CON1)
      REF = (RNWF*FKF*FKF)/373000.
      RRF = (REF * .62197)/(PRES - REF)
      RNF = RNWF + FNDF
      RETURN
      END
```

```
$IBFTC XWET     DECK
       SUBROUTINE WET
       COMMON /ADATA/ EH2O(1000)
       COMMON /ZPARAM/ ZS,RFS1,RFV1,RNM1,
                       RKP1,ANDF1,ANWF1,ACMRVP,
      1CORMR,CORVP,CORIN,ITPROB,IHUM,
                       IRSCT,PUNCH,KPAR,BETA1,BETA2,BETA3,
      2BETA4,BETA5,ALPHA,RADIUS,R,A
       COMMON /PATOUT/ PRES,SPEED,S,TKS4,
                       TEK,TVTX,FKF,TF,PTEMP,FNDF
       COMMON /WETOUT/ ARF,AEF,ANWF,ANF
       F00 = 1.4/.4
       UM = 1.
       IEW = TKS4*10. + 501.5
       IF (IEW.LE.0) GO TO 2
       EW = EH2O(IEW)
       GO TO 3
     2 EW = 0.
     3 CON  = 1. + BETA1*S*F00
       ARF = (UM*0.62197*EW)/(PRES*CON -EW)
       AEF = PRES*ARF/(.62197+ARF)
       ANWF = 373000.*AEF/(FKF**2)
       ANF = FNDF + ANWF
       IF (ANWF1) 6,6,4
     6 ANWF1 = ANWF
       ANDF1 = FNDF
     4 IF (RNM1) 7,7,5
     7 CON = 1. + BETA5*S*F00
       CON2 = 1. + BETA5*S
       RNWM1 = ANWF1*CON/(CON2**2)
       RNDM1 = (ANDF1*CON)/CON2
       RNM1 = RNWM1 + RNDM1
     5 RETURN
       END
```

```
$IBFTC XSFDAT  DECK
       SUBR0UTINE SFDATP
C      SKIP T0 AN END 0F FILE.
       C0MM0N /ZTAB/ P,N,TAB(400)
  100  CALL RDATP
       IF(N .NE. 0) G0 T0 100
       RETURN
       END
```

```
$IBFTC BLKPAR  DECK
      BLOCK DATA
      INTEGER PARAN
      COMMON /ZPARAN/NPAR,PARAN(2,60)
      COMMON /ZPARAM/ ZS,RFS1,RFV1,RNM1,
                  RKP1,ANDF1,ANWF1,ACMRVP,
     1 CORMR,CORVP,CORIN,ITPROB,IHUM,
                  IRSCT,PUNCH,KPAR,BETA1,BETA2,
     2 BETA3,BETA4,BETA5,ALPHA,RADIUS,R,A,PROCS,DUMP,
     3 PVMIN,PVMAX,PMIN,PMAX,SVMIN,SVMAX,
                  SMIN,SMAX,T4VMIN,T4VMAX,
     4T4MIN,T4MAX,
     5 EKVMIN,EKVMAX,EKMIN,EKMAX,VXVMIN,VXVMAX,VXMIN,VXMAX,
     6MISSID,TSTART,TSTOP,CPRES,CSPEED,
                  CKS4T,CEKT,CVXT,ZOFS1,CHKFC
      DATA NPAR/ 57/
      DATA((PARAN(I,J),I=1,2),J=1,27)/
     16HZS     ,1,6HRFS1   ,1,6HRFV1
                  ,1,6HRNM1   ,1,6HRKP1   ,1,6HANDF1 ,1,
     26HANWF1 ,1,6HACMRVP,1,6HCORMR
                  ,1,6HCORVP ,1,6HCORIN ,1,6HITPROB,2,
     36HIHUM   ,2,6HIRSCT ,2,6HPUNCH
                  ,3,6HKPAR   ,2,6HBETA1 ,1,6HBETA2 ,1,
     46HBETA3 ,1,6HBETA4 ,1,6HBETA5
                  ,1,6HALPHA ,1,6HRADIUS,1,6HR      ,1,
     56HA      ,1,6HPROCS ,3,6HDUMP   ,3/
      DATA((PARAN(I,J),I=1,2),J=28,47)/
     16HPVMIN ,1,6HPVMAX ,1,6HPMIN
                  ,1,6HPMAX   ,1,6HSVMIN ,1,6HSVMAX ,1,
     26HSMIN   ,1,6HSMAX   ,1,6HT4VMIN,1,6HT4VMAX,1,
     36HT4MIN ,1,6HT4MAX ,1,6HEKVMIN,
                  1,6HEKVMAX,1,6HEKMIN ,1,6HEKMAX ,1,
     46HVXVMIN,1,6HVXVMAX,1,6HVXMIN ,1,6HVXMAX ,1/
      DATA((PARAN(I,J),I=1,2),J=48,56)/
     16HMISID ,4,6HTSTART,5,6HTSTOP
                  ,5,6HCPRES ,1,6HCSPEED,1,6HCKS4T ,1,
     26HCEKT   ,1,6HCVXT   ,1,6HZOFS1 ,1/
      DATA PARAN(1,57),PARAN(2,57) /6HCHKFC   ,3/
      LOGICAL PUNCH,PROCS,DUMP,CHKFC
      DATA RFS1   /1871./
      DATA RFV1   /0./
      DATA RNM1   /316./
      DATA RKP1   /285.94/
      DATA ANDF1 /0./
      DATA ANWF1 /0./
      DATA ACMRVP/0./
      DATA CORMR /0./
      DATA CORVP /0./
      DATA CORIN /0./
```

```
DATA ITPR0B/1/
DATA IHUM  /0/
DATA IRSCT /1/
DATA PUNCH /.FALSE./
DATA KPAR  /1/
DATA BETA1 /.0002632/
DATA BETA2 /-.0002106/
DATA BETA3 /-.0000648/
DATA BETA4 / .0001316/
DATA BETA5 / .0000658/
DATA ALPHA /-.75/
DATA RADIUS/6357000./
DATA R     /6354120./
DATA A     /6356363./
DATA PR0CS /.TRUE./
DATA DUMP  /.FALSE. /
DATA ZS    /535.4117/
DATA PVMIN /18./
DATA PVMAX /1017./
DATA PMIN  /600./
DATA PMAX  /1060./
DATA SVMIN /691./
DATA SVMAX /1060./
DATA SMIN  /135./
DATA SMAX  /195./
DATA T4VMIN/190./
DATA T4VMAX/891./
DATA T4MIN /-40./
DATA T4MAX /35.9/
DATA EKVMIN/278./
DATA EKVMAX/769./
DATA EKMIN /-40./
DATA EKMAX /35.9/
DATA VXVMIN/241./
DATA VXVMAX/1050./
DATA VXMIN /-40./
DATA VXMAX /32./
DATA MISSID/1/
DATA TSTART/0./
DATA TST0P /86399./
DATA CPRES /0./
DATA CSPEED/0./
DATA CKS4T /0./
DATA CEKT  /0./
DATA CVXT  /0./
DATA Z0FS1 /914./
DATA CHKFC /.TRUE./
END
```

```
$IBMAP XKHAR    DECK
KHAR   SAVE     1,2,3,4,5
       ZET      NWMIS          STARTING A NEW MISSION
       TRA      STRTMS         YES.
KBEG   CLA*     3,4            GET CHARACTER COUNT
       SUB      KLAST          HOW MANY PAST LAST
       TMI      ERR            BACKWORDS IS A N ERROR
       PAX      ,1
       CLA*     3,4            THIS CHAR WILL
                               BE LAST ON NEXT ENTRY
       STO      KLAST
       TSX      NXTCHR,5       GET NEXT CHARACTER
       TIX      *-1,1,1        KEEP GOING UNTIL
                               HAVE PROPER ONE.
       PAC      ,1             CONVERT CHARACTER
       TXL      CKEOL,1,-33    IF IT I MORE
                               THAN 33 CHECK IF IT IS EOL.
       CLA      TABLE,1
       RETURN   KHAR
CKEOL  LDQ      =11            11 IS A BAD CHAR
       CAS      =0200          BUT CHECK IF IT IS EOL .
       TRA      *+2            NO.
       LDQ      =10            YES. EOL IS 1/
       XCA                     PUT IT IN AC.
       RETURN   KHAR
*
NXTCHR EQU      *              GET NEXT CHARACTER
       LAC      CURBIT,2       BITS LEFT
       TXL      NXTWRD,2,0
       TXH      NXTWRD,2,-8    TRA IF LESS THAN 8 BITS LEFT
       LDQ      CURWRD         GET WORD
       LGL      8                GET CHARACTER
       ANA      =0377
       STQ      CURWRD
       TXI      *+1,2,8        BUMB BIT COUNT.
       SCA      CURBIT,2
       TRA      1,5            RETURN
NXTWRD LXA      WRDCNT,3       NEED ANOTHER WORD
       TNX      RDREC,3,1      BUMP COUNNT,
                               AND TRA IF NO MORE.
       SXA      WRDCNT,3
SHIFTN LDQ      CURWRD         GET CURRENT WORD
       LGL      ,2               USE WHATEVER BIS IT HAS
       LAC      CURPOS,3       CURRENT POSITION IN BUFFER.
       LDQ      ,3             GET WORD.
       TXI      *+1,3,-1       BUMP.
       SCA      CURPOS,3       AND STORE.
       TXI      *+1,2,8        HOW MANY BITS OF NEW WORD.
       SXA      TEMP,2
```

```
         LAC     TEMP,2
         LGL     ,2          SHIFT IN
         STQ     CURWRD
         ANA     =0377
         TXI     *+1,2,36    REMAINING IN NEW W0RD
         SXA     CURBIT,2
         TRA     1,5
*
RDREC    CALL    RDATP       GET NEXT REC0RD
         NZT     N           IS IT E0F.
         TRA     E0F         YES.
RDREC1   AXT     TAB,4       N0. RESET P0INTERS.
         SXA     CURP0S,4
         CLA     N
         ST0     WRDCNT
         TRA     SHIFTN      G0 SHIFT IT IN.
STRTMS   STZ     CURBIT      START 0F MISSI0N
                             N0 BITS IN CURW0RD.
         STZ     WRDCNT      N0 W0RDS SIN BUFFER.
         STZ     KLAST       AND THERE WAS N0 LAST CHAR
         STZ     NWMIS       RESET NEW MISSI0N INDICAT0R.
         TRA     KBEG
E0F      CALL    RDATP
         AXT     0,2         A NEW FILE ALWAYS
                             STARTS A NEW CHARACTER
         ZET     N           IS IT D0UBLE END 0F FILE.
         TRA     RDREC1      N0. IGN0RE THE FIRST E0F.
         STL     E0M         YES. END 0F MISSI0N.
         STL     NWMIS
         CLA     =10
         RETURN  KHAR
ERR      CALL    EXIT
TABLE    EQU     *           BITS      0FFSET I
         DEC     11
         DEC     1           00000001  1
         DEC     2           00000010  2
         DEC     11                    3
         DEC     4           00000100  4
         DEC     11                    5
         DEC     11                    6
         DEC     7           00000111  7
         DEC     8           00001000  8
         DUP     1,10
         DEC     11
         DEC     3           00010011 19
         DEC     11                   20
         DEC     5           00010101 21
         DEC     6           00010110 22
         DEC     11                   23
```

```
         DEC     11                          24
         DEC     9               00011001    25
         DUP     1,6
         DEC     11
         DEC     0               00100000    32
CURBIT   PZE
CURWRD   PZE
CURP0S   PZE
WRDCNT   PZE
KLAST    PZE
TEMP     PZE
         L0RG
ZNWMIS   C0NTRL  ZNWMIS
         USE     ZNWMIS
NWMIS    BSS     1
ZE0M     C0NTRL  ZE0M
         USE     ZE0M
E0M      BSS     1
ZTAB     C0NTRL  ZTAB
         USE     ZTAB
P        BSS     1
N        BSS     1
TAB      BSS     400
         END
```

```
$IBMAP XLOGCO  DECK
*                              COMPARES TWO
                               ARGUMENTS AND RETURNS
*                              LOGICAL VARIABLE.
*                              TRUE IF THEY ARE EQUAL
*                              FALSE IF THEY ARE NOT.
       ENTRY   LOGCOM
LOGCOM NULL
       CLA*    3,4             FIRST ARG.
       SUB*    4,4
       TZE     TRET
       ZAC                     SET TO RETURN FALSE.
       TRA     1,4
TRET   CLA     =1              EQUAL. RETURN TRUE.
       TRA     1,4
       END
```

```
$IBMAP XRDATP  DECK
INPUT  FILE    ,A(1),DEFER,INPUT,BLK=254,BIN
RDATP  SAVE
       TSX     .0PEN,4          0PEN THE FILE EVERYTIME
       PZE     INPUT
       STZ     N                A ZER0 IN N MEANS
                                AN E0F WAS F0UND.
       TSX     .READ,4
       PZE     INPUT
       PZE     RET,,*-2
       I0RT    TAB,,**          INPUT INT0 TAB IN C0MM0N.
       LXD     *-1,4            PUT C0UNT
       SXA     N,4              IN N.
RET    RETURN  RDATP
ZTAB   C0NTRL  ZTAB
       USE     ZTAB
P      BSS     1
N      BSS     1
TAB    BSS     400
       END
$ENTRY         AIDA
```

```
$IBFTC TFILES
      BLOCK DATA
      COMMON /ZFILE / NFILES,FILEID(20)
      DATA NFILES,FILEID/20,
     X 6HFILE01,6HFILE02,6HFILE03,6HFILE04,
                6HFILE05,6HFILE06,6HFILE07,
     X 6HFILE08,6HFILE09,6HFILE10,6HFILE11,
                6HFILE12,6HFILE13,6HFILE14,
     X 6HFILE15,6HFILE16,6HFILE17,6HFILE18,
                6HFILE19,6HFILE20 /
      END
```

```
$IBFTC XBLK
      BL0CK DATA
      INTEGER FILEID
      L0GICAL PLTPT
      INTEGER XEMPH,HTEMPH,HTLAB,HTCHR
      INTEGER SUB
      L0GICAL LG0,LNUMG0
      REAL LFR0M,LT0,LBY
      REAL LHTFR,LHTT0,LHTBY
      L0GICAL LFRG0
      L0GICAL LSG0,LSGRK
      L0GICAL 0RD
C
      C0MM0N /Z0RD/ 0RD
      C0MM0N /ZPL0TS/NFRAME,NPL0TS(10)
      C0MM0N /ZGRIDX/ MTL(10),MTR(10),
                     XL(10),XR(10),DX(10),XEMPH(10),
     X NXLAB(10),NXCHR(10)
      C0MM0N /ZGRIDH/ HTL0W(10),HTMAX(10),
                     DHT(10),HTEMPH(10),HTLAB(10),
     X HTCHR(10),MTB(10),MTT(10)
      C0MM0N /ZSUB/ SUB(10)
      C0MM0N /ZPLTPT/ PLTPT(25)
      C0MM0N /ZVRTTL/ LVRSZ(2),LVRX,LVRY,LVRDUM(6),VARTTL(5)
      C0MM0N /ZFMT/ FMT(10)
      C0MM0N /ZNVAR/NVAR
      C0MM0N /ZJ0B/NJ0BC,J0BID(10)
      C0MM0N /ZLABEL/ LG0(10),LALPH(5,
                     10),LSIZE(2,10),LNY(10),LNX(10)
      C0MM0N /ZLNUM/ LNUMG0(10),LNUMY(10),
                     LNUMSZ(2,10),LFR0M(10),
     X  LT0(10),LBY(10)
      C0MM0N /ZLFR/ LHTFR,LHTT0,LHTBY,
                     LHTIX,LHTSIZ(2),LFRG0(10),
     X  LFRSIZ(2)
      C0MM0N /ZLS/ LSG0(10),LSSZ(2),LSCHR(10),LSGRK(10)
      C0MM0N / ZHTLBL/ LHTLX,LHTLY
C
C FMT C0NTAINS THE F0RMAT F0R READING THE DATA.
      DATA FMT(1)/12H(I6,7F7.1)                    /
C
C PLTPT(I)=.TRU. MEANS PL0T THE ITH
                     VARIABLE AS DISCRETE P0INTS
C           .FALS. MEANS PL0T IT AS A C0NTINU0US LINE.
      DATA (PLTPT(I),I=1,5)  /5*.FALSE./
C
C THE F0LL0WING ESTABLISHES THE VERTICAL GRID (I.E. GRID F0R
C      HRIZ0NTAL LINES) WHICH REFERS T0 HEIGHT.
C      EACH VARIABLE C0ULD HAVE ITS 0WN GRID IF DESIRED.
```

```
C HTLOW IS THE LOWEST HEIGHT TO BE PLOTTED
C HTMAX IS THE LARGEST HEIGHT TO BE PLOTTED.
C DHT IS THE HEIGHT BETWEEN GRID LINES.
C HTEMPH INDICATES WHICH GRID LINES ARE TO BE DARKENED.
C        (HTEMPH=N MEANS DARKEN EVERY NTH GRID LINE)
C HTLAB, AND HTCHR CONTROL THE AUTOMATIC
                  LABELLING OF GRID1V.
C THEY ARE NO LONGER USED.
      DATA (HTLOW(I),HTMAX(I),DHT(I),
                  HTEMPH(I),HTLAB(I),HTCHR(I),I=1,5)
     X / 0.,4000.,500.,10,10,0,
     X 0.,4000.,0.,0,0,0,
     X 0.,4000.,500.,10,0,0,
     X 0.,4000.,0.,0,0,0,
     X 0.,4000.,0.,0,0,0   /
C
C NFRAME=NUMBER OF SEPARATE FRAMES
C NPLOTS(I)=HOW MAYNY VARIABLES TO PLOT ON EACH FRAME.
      DATA NFRAME,(NPLOTS(I),I=1,2) /2,2,3/
      DATA NVAR /5/
C
C MTL,MTR,MTB,MTT CONTROL THE MARGIN
                  SETTINGS OF LEFT RIGHT TOB A
C MTL(I),MTR(I),MTB(I),MTT(I) CONTROL
                  THE PLACEMENT OF THE GRID FOR
C THE ITH VARIABLE.
C THEY ARE THE MARGINS (IN RASTER UNITS)
                  TO BE LEFT ON THE LEFT,RIGHT,
C     BOTTOM, AND TOP OF THE GRID RESPECITIVELY.
      DATA (MTL(I),MTR(I),MTB(I),MTT(I),I=1,5) /
     1 80,5,75,260,
     1 80,5,75,260,
     1 80,5,75,260,
     1 80,5,75,260,
     1 80,5,75,260/
C
C XL,XR,DX,XEMPH,NXLAB,NXCHR ESTABLEISH
                  THE SCALLING FOR THE VARIABLES
C     WHICH ARE PLOTTED IN THE X DIRECTION,
                   (I.E. VERITICAL GRID LINES)
C THEIR MEANING CORRSPONDS TO BE MEANING
                  FOR THE VERTICAL SCALING.
      DATA ( XL(I),XR(I),DX(I),XEMPH(I),
                  NXLAB(I),NXCHR(I),I=1,5) /
     1 150.,400.,50.,10,0,0,
     A 300.,800.,0.,0,0,0,
     3 -5.,45.,5.,2,0,0,
     4 -5.,45.,0.,0,0,0,
     5 0.,25.,0.,0,0,0 /
```

```
C
C
C SUB CONTROLS THE ORDER IN WHICH THE
                  VARIABLES ARE PLOTTED, S
C THE ITH VARIABLE WAS THE SUB(I)TH
                  NUMBER READ FROM THE INPUT RECORD.
      DATA (SUB(I),I=1,5) /1,2,3,4,5/
C
C LVRSZ = SIZE FOR LABEL CHARACTERS
                  (I.E. VARIABLE ALPHA CHARS)
C LVRX,LVRY = X AND Y COORD OF START OF VARIABLE TITLE
C
      DATA LVRSZ(1),LVRSZ(2),LVRX,LVRY /3,3,400,12/
C
C NJOBID IS PRINTED IN THE FIRST FRAME
                  OF A ROLL TO DITIFY THE JOB.
C NJOBC=NUMPBER OF CHARACTERS IN JOBID.
      DATA NJOBC,JOBID(1) /7,7H WILSON /
C
C LGO(I)=.TRUE. MEANS THAT THERE IS
                  AN ALPHABETIC LABEL ASSOCIATED
C WITH THE ITH VARIABLE. THE LABEL IS CONTAINED IN
C LALPH(1,I) ... LALPH(5,I)
      DATA (LGO(I),I=1,5) /3*.TRUE.,.FALSE.,.TRUE.  /
      DATA (LALPH(1,I),I=1,5)      /
     1 30HREFRACTIVITY (N UNITS)                    ,
     2 30HREFRACTIVITY (M UNITS)                    ,
     3 30HTEMPERATURE (DEGREES C)                   ,
     4 0,30HVAPOR PRESSURE (MB.)                        /
C
C LSIZE(1,I),LSIZE(2,I) ARE THE
C LSIZE(1,I),LSIZE(2,I) INDICATE THE
                  SIZE OF THE LABELING FOR THE
C ITH VARIABLE. L
      DATA ((LSIZE(I,J),I=1,2),J=1,5) /10*2/
C
C LNX(I),LNY(I) ARE THE X AND Y RASTER
                  CORDINATES AT WHICH TO BEGIN
C PRINTING THE LABEL FOR THE ITH VARIABLE.
      DATA (LNX(I),LNY(I),I=1,5) /400,
                  36,400, 812,400,36,2*0,400, 812 /
C
C LNUMGO(I)=.TRUE. IDICATES THAT THE
                  GRID FOR THE ITH VARIABLE SHOULD
C HAVE NUMERIC LABELS ATTACED.
      DATA(LNUMGO(I),I=1,5) /3*.TRUE.,.FALSE.,.TRUE./
C
C LNUMSZ(1,I),LNUMSZ(2,I) INDICATE THE
                  SIZE OF THENUMERIC LABELS.
```

```
      DATA ((LNUMSZ(I,J),I=1,2),J=1,5) /10*2/
C
C LNUMY(I) IS THE Y RASTER COORDINATE
                  FOR THE NUMERICA LABELS A OF THE
C ITH VARIABLE. THE X COORDINATE IS
                  DETERMINED BY THE VALUSE TO BE PRINT
      DATA (LNUMY(I),I=1,5) / 53,792,53,0,792 /
C
C LFROM(I),LTO(I),LBY(I) INDICATE THE
                  NUMBERS TO BE USED AS NUMERIC
C LABELS.  LABELS ARE PLACED UNDER THE
                  GRID AT POSITIONS CORRESPONDING
C TO NUMBERS BETWEEN LFROM(I), AND LTO(I),
                   SEPARATED BY LBY(I)
      DATA (LFROM(I),LTO(I),LBY(I),I=1,5) /150.,400.,50.,
     X 300.,800.,100., 0.,40.,10., 3*0., 0.,25.,5.  /
C
C LHTFR,LHTTO,LHTBY ARE SIMILAR TO LFROM,
                  LTO,LBY EXCEPT THEY ARE USED
C IN LABELING THE HEIGHT COORDINATE.
      DATA LHTFR,LHTTO,LHTBY /0.,4000.,500. /
C
C LHTIX,LHTSIZ CORRESPON TO LNUMY AND
                  LNUMSZ FOR THE HEIGHT CORRD.
      DATA LHTIX,LHTSIZ(1),LHTSIZ(2) / 30,2,2/
C
C LFRGO(I)=LABEL A FRAME WITH THE HEIGHT
                  COORDINATES AND VARIABLE
C DESCRIPTION FREAD AS INPUT.
      DATA (LFRGO(I),I=1,5) /.TRUE.,
                  .FALSE.,.TRUE.,2*.FALSE./
C
C ORD=.TRUE. MEANS PLOT THE POINTS IN ORDER BY HEIGHT.
C ORD=.FALSE. MEANS PLOT THE POINTS
                  IN THE ORDER THE ARE READ IN.
C THIS ONLY EFFECTS VARIABLES FOR WHICH PLTPF=.FALSE.
      DATA ORD/.TRUE./
C
C LSGO CONTROLS THE LABELING OF LINES FOR EACH VAR
C LSGO(I)=.TRUE. MEANS LABEL THE LINE
                  WITH THE CHARACTER LSCHR(I).
C THE CHARACTER IS PLACED JUST ABOVE
                  THE HEIGHEST POINT WHICH WAS PLOTTE
      DATA (LSGO(I),I=1,5) /5*.TRUE./
      DATA (LSCHR(I),I=1,5) /6HOOOOON,
                  6HOOOOOM,6HOOOOOT,7,6HOOOOOE/
C
C LSSZ CONTROLS THE SIZE OF THE CHARACTERS
                  USED TO LABEL LINES.
```

```
      DATA LSSZ(1),LSSZ(2) /3,3/
C
C

C LSGRK INDICATES WHETER THE CHARACTER
                  USED TO LABEL THE VARIABLES IS
C TO BE ROMAN OR GREEK.  LSGRK(I)=.TRUE.
                  MEANS THE CHARACTER FOR THE
C ITH VARIABLE IS GREEK, .FALSE. MEANS ROMAN.
      DATA (LSGRK(I),I=1,5) /3*.FALSE.,.TRUE.,.FALSE. /
C
C LHTLX,LHTLY = X,Y START COORD OF TITLE WHE SAYS 'HE+GHT'
C
      DATA LHTLX,LHTLY /10,300 /
      END
```

```
$IBFTC SMLBLK
      BL0CK DATA
C 0NLY SETS VARIABLES WHICH ARE DIFFERENT
                  FR0M VALUSE REQUIRED F0R
C LARGE PL0TS
C PUTS B0TH PL0TS 0N 0NE FRAME IN REDUCED SIZE
C SETS UP C0MM0NS T0 PL0T A REDUCED SIZE
      INTEGER XEMPH,HTEMPH,HTLAB,HTCHR
      REAL LHTFR,LHTT0,LHTBY
      C0MM0N /ZLNUM/ LNUMG0(10),LNUMY(10),
                  LNUMSZ(2,10),LFR0M(10),
     X  LT0(10),LBY(10)
      C0MM0N /ZVRTTL/ LVRSZ(2),LVRX,LVRY,LVRDUM(6),VARTTL(5)
      C0MM0N /ZLABEL/ LG0(10),LALPH(5,
                  10),LSIZE(2,10),LNY(10),LNX(10)
      C0MM0N / ZHTLBL/ LHTLX,LHTLY
      C0MM0N /ZGRIDX/ MTL(10),MTR(10),
                  XL(10),XR(10),DX(10),XEMPH(10),
     X NXLAB(10),NXCHR(10)
      C0MM0N /ZGRIDH/ HTL0W(10),HTMAX(10),
                  DHT(10),HTEMPH(10),HTLAB(10),
     X HTCHR(10),MTB(10),MTT(10)
      C0MM0N /ZLFR/ LHTFR,LHTT0,LHTBY,
                  LHTIX,LHTSIZ(2),LFRG0(10),
     X  LFRSIZ(2)
      C0MM0N /ZLS/ LSG0(10),LSSZ(2),LSCHR(10),LSGRK(10)
      C0MM0N /ZPL0TS/NFRAME,NPL0TS(10)
      DATA (HTL0W(I),HTMAX(I),DHT(I),
                  HTEMPH(I),HTLAB(I),HTCHR(I),I=1,5)
     X / 0.,4000.,1000.,10,0,0,
     X 0.,4000.,0.,0,0,0,
     X 0.,4000.,1000.,10,0,0,
     X 0.,4000.,0.,0,0,0,
     X 0.,4000.,0.,0,0,0  /
      DATA (MTL(I),MTR(I),MTB(I),MTT(I),I=1,5) /
     1 80,500,75,660,
     1 80,500,75,660,
     1 575,0,75,660,
     1 575,0,75,660,
     1 575,0,75,660   /
      DATA LHTBY /1000./
      DATA LNUMY /53,392,53,0,392,5*0/
      DATA (LNX(I),LNY(I) ,I=1,5) /150,
                  36,150,412,670,36,2*0,670,412 /
      DATA LHTLX,LHTLY / 10,150/
      DATA LSSZ /2,2/
      DATA NFRAME /1/
      DATA NPL0TS(1) /5/
      DATA LVRSZ,LVRX,LVRY / 3,3,300,12 /
```

```
      END
```

```
$IBFTC XPL0T
      C0MM0N /ZVAR/ VAR(2000,5)
      C0MM0N /ZHT/ NPTS,HT(2000)
      C0MM0N /ZPL0TS/NFRAME,NPL0TS(10)
      C0MM0N /ZGRIDH/ HTL0W(10),HTMAX(10),
                  DHT(10),HTEMPH(10),HTLAB(10),
     X HTCHR(10),MTB(10),MTT(10)
      C0MM0N /ZGRIDX/ MTL(10),MTR(10),
                  XL(10),XR(10),DX(10),XEMPH(10),
     X NXLAB(10),NXCHR(10)
      C0MM0N /ZPLTPT/ PLTPT(25)
      C0MM0N /ZSUB/ SUB(10)
      C0MM0N /ZJ0B/NJ0BC,J0BID(10)
      INTEGER SUB
      L0GICAL PLTPT
      INTEGER HTEMPH,HTLAB,HTCHR,XEMPH
      EXTERNAL TABL1V
      WRITE(6,902)
       CALL CHSIZV(15,9)
      CALL RITSTV(150,150,TABL1V)
      CALL RITE2V(50,500,1000 ,90,1,NJ0BC,-1,J0BID,NERR  )
      CALL PRINTV(-7,7HSCHWARZ,50,50)
  100 C0NTINUE
      CALL INPUT
      CALL 0RDER
      NVAR=0
      D0 300 NFR=1,NFRAME
      CALL FRAMEV(2)
      N2=NPL0TS(NFR)
      D0 200 I=1,N2
      NVAR=NVAR+1
      NS=SUB(NVAR)
C NS=0 INDICATES THAT THAT VARIABLE IS MISSING.
      IF(NS.EQ.0) G0 T0 200
      CALL SETMIV(MTL(NVAR),MTR(NVAR),MTB(NVAR),MTT(NVAR) )
      CALL GRID1V(2,XL(NVAR),XR(NVAR),
                  HTL0W(NVAR),HTMAX(NVAR),
     X DX(NVAR),DHT(NVAR),XEMPH(NVAR),
                  HTEMPH(NVAR),NXLAB(NVAR),
     X HTLAB(NVAR),NXCHR(NVAR),HTCHR(NVAR) )
      CALL TITLE(NVAR)
      IF(.N0T.PLTPT(NFR)) G0 T0150
      CALL APL0TV(-NPTS,VAR(1,NS),HT,1,1,1,42,NERR)
       IF(NERR.GT.0) WRITE(6,900) NERR
       G0 T0 200
  150 NERR=0
      D0 160 J=1,NPTS
      JL=J+1
       NXL=NXV(VAR(J,NS))
```

```
      NYL=NYV(HT(J))
      IF(NXL.NE.0 .AND. NYL.NE.0) GO TO 165
  160 NERR=NERR+1
  165  DO 180 J=JL,NPTS
      NXN=NXV(VAR(J,NS))
      NYN =NYV(HT(J))
      IF(NXN .EQ.0 .OR. NYN.EQ.0) GO TO 170
      CALL LINEV(NXL,NYL,NXN,NYN)
      NXL=NXN
      NYL=NYN
      GO TO 180
  170 NERR=NERR+1
  180 CONTINUE
      IF(NERR.NE.0) WRITE(6,900) NERR
  200 CONTINUE
  300 CONTINUE
      GO TO 100
  900 FORMAT( 11H THERE WERE,I5,12H BAD POINTS.)
  901 FORMAT(1H1,9X,6HHEIGHT/(10X,6F10.2))
  902 FORMAT(1H1)
      END
```

```
$IBFTC XINPUT
      SUBROUTINE INPUT
      COMMON /ZHT/ NPTS,HT(2000)
      COMMON /ZVAR/ VAR(2000,5)
      COMMON /ZVRTTL/ XVTTL(5),YVTTL(5),VARTTL(5)
      COMMON /ZNVAR/NVAR
      COMMON /ZFMT/FMT(10)
      COMMON /ZFILE/ NFILES,FILEID(20)
      INTEGER FILEID,FILE,FIL
      INTEGER CURFIL
      INTEGER XVTTL,YVTTL
      LOGICAL EOF
      DATA MAXPTS/2000/
      DATA NSTOP/6H*STOP* /
      DATA CURFIL/1/
C
C     INPUT SUBROUTINE
C     READ IN REQUESTS. AND APPROPRIATE DATAS.
  100 NPTS = 0
      READ(5,900) MISSR,KLOW,KHI,CONTEX,VARTTL
      IF( MISSR .EQ. NSTOP) STOP
      DO 110 FIL=1,NFILES
      FILE = FIL
  110 IF(FILEID(FIL).EQ.MISSR) GO TO 120
      WRITE(6,901) MISSR
C THE REQUESTED MISSION IS NOT ON THE TAPE.
      GO TO 100
  120 IF(CURFIL .EQ. FILE) GO TO 150
      IF(CURFIL .LT. FILE) GO TO 130
C     THIS FILE IS BEFORE CURRENT FILE
      WRITE(6,902) MISSR
      GO TO 100
  130 NSKIP = FILE-CURFIL
C SKIP FILES TO PROPER ONE
      DO 140 N=1,NSKIP
  140 CALL SKPFIL
      CURFIL=FILE
  150 CONTINUE
  200 READ(1,FMT) KOUNT,HT(NPTS+1),(VAR(NPTS+1,I),I=1,NVAR)
      IF(EOF(1)) GO TO 290
      IF(KOUNT .LT. KLOW) GO TO 200
      IF(KOUNT .GT. KHI) GO TO 300
      NPTS = NPTS+1
      IF(NPTS .GE. MAXPTS) GO TO 300
      IF(KOUNT .EQ. KHI) GO TO 300
      GO TO 200
  290 CURFIL=CURFIL+1
  300 WRITE(6,903) VARTTL,MISSR,KLOW,KHI,NPTS
      IF(NPTS .EQ. 0) GO TO 100
```

```
      RETURN
  900 F0RMAT(A6,2X,2I5,A1,5A6)
  901 F0RMAT(20HOTHERE IS N0 MISSI0N
                 A6/17H REQUEST IGN0RED.  )
  902 F0RMAT(20HOREQUEST F0R MISSI0N
                 A6,17H IS 0UT 0F 0RDER./
     X 17H REQUEST IGN0RED.   )
  903 F0RMAT(11HOGRAPHS F0R,1X,5A6,3X,
                 7HMISSI0N,A6,5H FR0M,I5,3H T0,
     X I5,1H.,I6,13H DATA P0INTS. )
  904 F0RMAT(A1,10I5)
  905 F0RMAT( 25H T00 MANY EXCLUSI0N CARDS)
      END
```

```
$IBFTC XINRAD
C INPUT R0UTINE F0R THE RADI0S0NDE DATA
                (WHICH HAS ALREADY BEEN
C PR0CESSED 0NT0 A TAPE)
C
      SUBR0UTINE INPUT
      INTEGER VARTTL,FIXTTL
      DIMENSI0N KDAY(50),KSTAT(50),FIXTTL(5)
      L0GICAL FIRST
      L0GICAL E0F
      C0MM0N /ZHT/ NPTS,HT(2000)
      C0MM0N /ZVAR/ VAR(2000,5)
      C0MM0N /ZVRTTL/ XXV(10),VARTTL(5)
      C0MM0N /ZSUB/ NSUB(10)
      DIMENSI0N ISUB(10)
      DATA ISUB/5,4,1,3,2,5*0/
      L0GICAL ALLSTA,ALLDAY
      DATA FIXTTL(1) /30HSTAT,DAY,HR
                                      /
      DATA FIRST/.TRUE./
C 0NLY D0 INITIALIZATI0N 0NCE
      IF(.N0T.FIRST) G0 T0 100
      D0 10 I=1,5
10    NSUB(I)=ISUB(I)
      READ(5,900) NSTAT, (KSTAT(I),I=1,NSTAT)
      READ(5,900) NDAY,(KDAY(I),I=1,NDAY)
      WRITE(6,901) NSTAT,(KSTAT(I),I=1,NSTAT)
      WRITE(6,902) NDAY, (KDAY(I),I=1,NDAY)
      ALLSTA=NSTAT.LE.0
      ALLDAY = NDAY.LE.0
 100  FIRST=.FALSE.
C READ HEADER REC0RD
      READ(1) MSTAT,NX,NX,NX,MHR,MDAY,MM0,IB0T,IT0P
      IF(E0F(1)) ST0P
      READ(1) ((VAR(I,J),J=1,4),I=1,500)
      READ(1) SKIP
      IF(ALLSTA) G0 T0 140
      D0 130 I=1,NSTAT
 130  IF(KSTAT(I).EQ.MSTAT) G0 T0 140
      G0 T0 100
 140  IF(ALLDAY) G0 T0 160
      D0 150 I=1,NDAY
 150  IF(KDAY(I) .EQ. MDAY) G0 T0 160
      G0 T0 100
 160  C0NTINUE
      D0 180 I=1,5
 180  VARTTL(I)=FIXTTL(I)
       VARTTL(3) = MSTAT
      VARTTL(4)=MDAY
```

```
      VARTTL(5) = MHR
      WRITE(6,903) VARTTL
C     THE DATA MUST BE MADE INTO WHAT WE WANT TO PLOT.
      NPTS=ITOP-IBOT+1
      DO 200 N=1,NPTS
      NN=N+IBOT-1
C VAR(3) IS HT
      HT(N)=VAR(NN,3)
C VAR(1) IS TEMPERATURE
      VAR(N,1) = VAR(NN,1)
C VAR(2) IS DEW POINT, CHANGE IT TO VAPOR PRESSURE
C THE FORMULA USED IS AN EMPIRICAL RELATION
                  DETERMINED BY JOHN SKILLMAN
      VAR(N,2)= 10.**(25.058-3009.5/(273.2+VAR(NN,2))
     X  -5.439*ALOG10(273.2+VAR(NN,2)) )
C VAR(4) IS M, IT DOES NOT HAVE TO BE CHANGED.
      VAR(N,4)=VAR(NN,4)
C SETUP VAR(5) AS N.
      VAR(N,5) =VAR(NN,4)-VAR(NN,3)/6371.2E3 *1.E6
C     VAR 3 IS POTENTIAL TEMPERATURE
      PRES=1013.*EXP(-980.*HT(N)*100./2.87E6/280.)
      VAR(N,3)=(VAR(N,1)+273.)*(1000./PRES)**.286-273.0
  200 CONTINUE
      RETURN
  900 FORMAT(I6,11A6/(12A6))
  901 FORMAT(1H1,I4,10H STATIONS.11A6/(15X,12A6))
  902 FORMAT(I5,6H DAYS.4X,11A6/(15X,12A6))
  903 FORMAT(5X,5A6)
      END
```

```
$IBFTC X0RDER
      SUBR0UTINE 0RDER
      C0MM0N /Z0RD/ 0RD
      C0MM0N /ZHT/ NPTS,HT(2000)
      C0MM0N /ZVAR/ VAR(2000,5)
      L0GICAL 0RD
      DATA MAXVAR/5/
      L0GICAL UP,D0WN
      IF(.N0T.0RD) RETURN
      UP = HT(NPTS) .GT. HT(1)
C     S0RT WILL BE ASCENDING 0R DESCENDING
                DEPENDING 0N 0VERALL
C     DIRECTI0N.
      D0WN = .N0T. UP
      N = 1
  100 IF (N .GE. NPTS) RETURN
      IF(UP.AND.HT(N).GT.HT(N+1) ) G0 T0 150
      IF( D0WN.AND.HT(N).LT.HT(N+1) ) G0 T0 150
      N = N+1
      G0 T0 100
  150 C0NTINUE
      X = HT(N)
      HT(N)=HT(N+1)
      HT(N+1)=X
      D0 200 I=1,MAXVAR
      X=VAR( N,I)
      VAR(N,I)=VAR(N+1,I)
  200 VAR(N+1,I)=X
      N=N-1
      IF(N.LE. 0) N=1
      G0 T0 100
      END
```

```
$IBFTC XTITLE
      SUBR0UTINE TITLE(NVAR)
      EXTERNAL TABL1V
      EXTERNAL TABL2V
      INTEGER SUB
      INTEGER XVTTL,YVTTL
      REAL LHTFR,LHTT0,LHTBY
      L0GICAL LFRG0
      L0GICAL LG0,LNUMG0
      L0GICAL LSG0,LSGRK
      REAL LFR0M,LT0,LBY
      C0MM0N /ZLS/ LSG0(10),LSSZ(2),LSCHR(10),LSGRK(10)
      C0MM0N / ZHTLBL/ LHTLX,LHTLY
      C0MM0N /ZVRTTL/ LVRSZ(2),LVRX,LVRY,LVRDUM(6),VARTTL(5)
      C0MM0N /ZLABEL/ LG0(10),LALPH(5,
                  10),LSIZE(2,10),LNY(10),LNX(10)
      C0MM0N /ZLNUM/ LNUMG0(10),LNUMY(10),
                  LNUMSZ(2,10),LFR0M(10),
     X  LT0(10),LBY(10)
      C0MM0N /ZLFR/ LHTFR,LHTT0,LHTBY,
                  LHTIX,LHTSIZ(2),LFRG0(10),
     X  LFRSIZ(2)
      C0MM0N /ZVAR/ VAR(2000,5)
      C0MM0N /ZHT/NPTS,HT(2000)
      C0MM0N /ZSUB/ SUB(10)
      NUSED=0
      IF(.N0T.LFRG0(NVAR)) G0 T0 150
      CALL CHSIZV(LVRSZ(1),LVRSZ(2))
      CALL RITSTV(5*LVRSZ(1),26,TABL1V)
      CALL RITE2V(LVRX,LVRY,1023,90,1,30,-1,VARTTL,NUSED)
      CALL CHSIZV(LHTSIZ(1),LHTSIZ(2))
      CALL RITSTV(LHTSIZ(1)*5+3,26,TABL1V)
      CALL RITE2V(LHTLX,LHTLY,1023,180,
                  1,15,-1,15HHEIGHT (METERS),NUSED)
      AT=LHTFR
  125 CALL BNBCDV(AT,BCD,NDS)
      CALL RITE2V(LHTIX,NYV(AT),1000,90,1,NDS,-1,BCD,NUSED)
      AT=AT+LHTBY
      IF(AT.LE.LHTT0) G0 T0 125
  150 C0NTINUE
      IF(.N0T. LG0(NVAR)) G0 T0 200
      CALL CHSIZV(LSIZE(1,NVAR),LSIZE(2,NVAR) )
      CALL RITSTV(5*LSIZE(1,NVAR)+3,26,TABL1V)
      CALL RITE2V(LNX(NVAR),LNY(NVAR),
                  1000,90,1,30,-1,LALPH(1,NVAR),
     X  NUSED)
  200 C0NTINUE
      IF (.N0T.LNUMG0(NVAR))  G0 T0 300
      CALL CHSIZV(LNUMSZ(1,NVAR),LNUMSZ(2,NVAR) )
```

```
      CALL RITSTV(5*LNUMSZ(1,NVAR)+3,26,TABL1V)
      AT = LFROM(NVAR)
  250 CALL BNBCDV(AT,BCD,NSD)
      LEFT=NSD* (5*LNUMSZ(1,NVAR)+3) -3
      CALL RITE2V(NXV(AT)-LEFT,LNUMY(NVAR),
                  1023,90,1,NSD,-1,BCD,NUSED)
      AT = AT+LBY(NVAR)
      IF(AT.LE.LTO(NVAR)) GO TO 250
  300 CONTINUE
      IF(.NOT.LSGO(NVAR)) GO TO 350
      NS=SUB(NVAR)
      H=.0
      DO 310 I=1,NPTS
      IF( H.GE.  HT(I) .OR. NYV(HT(I)).EQ.0
                  .OR. NXV(VAR(I,NS)) .EQ.0)
     X  GO TO 310
      H=HT(I)
      X=VAR(I,NS)
  310 CONTINUE
      CALL CHSIZV(LSSZ(1),LSSZ(2))
      IF(.NOT.LSGRK(NVAR)) CALL VCHARV(90,
                  1,NXV(X)-5*LSSZ(1),NYV(H)+3,
     X  LSCHR(NVAR),TABL1V)
      IF(     LSGRK(NVAR)) CALL VCHARV(90,
                  1,NXV(X)-5*LSSZ(1),NYV(H)+3,
     X  LSCHR(NVAR),TABL2V)
  350 CONTINUE
      RETURN
      END
$IBFTC XSKP
      SUBROUTINE SKPFIL
      LOGICAL EOF
   10 READ(1,11) I
   11 FORMAT(A1)
      IF(EOF(1)) RETURN
      GO TO 10
      END
```

TRACE SUBROUTINES

TRACE	Main routine controls flow of program.
XGETCR	Reads control cards and profiles. Sets up COMMONS for tracing. Returns when a *TRACE card is encountered.
XGETRA	Sets up for next ray, if any.
XBUMP	Performs iteration.
XHTINT	Function which returns refractive indexes. Its arguments are height and range and it normally performs some interpolation. Also puts in common the limits of linearity for the interpolation it performed.
XDFIND	Utility routine to locate data in a table.
XATTEN	Computes attenuation and reflection from layer or surface.
XPRINT	Produces all printed output.
SFINISH	Logical function which decides whether or not to continue tracing current ray.
TRCBLK	Block data containing certain defaults and sizes.
XPLRAY	Performs manipulation of intermediate plotting tapes at end of ray.
XOUTAL	Performs plotting of all rays traced since it was last called. This is the only routine which calls the assembly language plotting routines.
XPLTPO	Adds current position to intermediate plotting tape.

```
$IBJOB          MAP
$IBFTC TRACE
       LOGICAL SUC
       DOUBLE PRECISION NHT,NTHETA,NEL,NN,NRNG
       DOUBLE PRECISION CHT,CTHETA,CEL,CN,CRNG
       DOUBLE PRECISION NPOS(5),CPOS(5)
       LOGICAL HOLD
       COMMON /ZHOLD/HOLD
       COMMON /CURPOS/ CHT,CTHETA,CEL,CN,CRNG
       COMMON /NXTPOS/ NHT,NTHETA,NEL,NN,NRNG
       EQUIVALENCE (CPOS(1),CHT ),(NPOS(1),NHT )
C AUTHOR. JERALD SCHWARZ
C DATE JUNE 1969.
C
C COMMONS AND VARIABLES
C  /CURPOS/  COMMON CONTAINING THE CURRENT
C                  POSITION OF THE RAY
C     CHT= CURRENT HEIGHT (IN METERS)
C     CTHETA = CURRENT THETA (EARTH
C                  CENTRAL ANGLE IN RADIANS)
C     CEL = CURRENT ELEVATION O ANGLE (IN RADIANS)
C     CN= CURRENT REFRACTIVE INDEX
C     CRNG= CURRENT RANGE (ALONG EARTH) IN METERS.
C  /NXTPOS/ COMMON CONTAINING THE NEXT POSITION OF RAY
C           I.E. POSITION BEING CALCULATIOED.
C           VARIABLES ARE SAME AS IN
C                  CURPOS EXCEPT NAMES HAVE N AS PREFIX
C  /ZTRCP/  CONTAINS TRACE CONTROL PARAMETERS
C     STRTRG = START RANGE OF NEXT RAY
C     STRTHT = START HEIGHT OF NEXT RAY (IN METERS)
C     STRTEL = START ELEVATION OF NEXT RAY (IN RADIANS)
C     STPRNG = RANGE AT WHICH TO STOP TRACING
C     BMPCT = NUMBER OFRAYS LEFT TO
C                  TRACE IN THIS SET (A SET IS DETER-
C           MINED BY VBMP AND DEL)
C     VBMP CONTROLS WHICH START PARAMETER
C                  SHOULD BE INCREMENTED
C           =1 INCREMENT START RANGE.
C           =2 INCREMENT START HIEGHT.
C           =3 INCREMENT START ELEVATION.
C     DEL = AMOUNT TO INCREMENT PARAMETER
C                  EACH TIME PROGRAM STARTS A NEW
C           RAY.
C  /ZRAD/ ERAD = EARTH'S RADIUS IN METERS.
C  /ZIXP/ IXPROF = THE NUMBER OF THE CURRENT PROFILE.
C  /ZSNELL SNELLC = THE CONSTANT OF
C                  SNELLS LAW FOR THIIS RAY.
C           I.E. N*(1.+HEIGHT/RADIUS)*COS(ELEVATION)
C  /ZUP/ UP = .TRUE. WHEN RAY IS PROCEEDING UPWARD
```

```
C           =FALSE WHEN RAY IN GOING DOWNWARD.
C           IT IS SET BY GETRAY AND CHANGED BY BUMP.
C  /ZPROF/  CONTAINS INFORMATION ABOUT PROFILES
C     NUMP= NUMBER OF PROFILES IN CORE.
C     PHT(I,J) = HEIGHT OF ITH POINT OF JTH PROFILE.
C     PN(I,J) = REFRACTIVE INDEX OF ITH POINT OF JTH PROFILE
C     MAXP(J) = NUMBER OF POINTS IN JTH PROFILE
C    PRNG(J) = RANGE AT WHICH JTH PROFILE IS SITUATIED
C  /ZDIM/
C     DIMP1 = LIMIT OF NUMBER OF POINTS IN A PROFILE
C     DIMP2 = LIMIT ON NUMBER OF PROFILE
                  S IN CORE (I.E. ON A PATH)
C  /ZTITLE/ TITLE=BCD ARRAY WITH LABELING
                  FOR THIS SET OF TRACES.
C  /ZDELHT/ DELHT = INCREMENT IN HEIGHT BETWEEN POINTS.
C           IT IS USED BY BUMP TO GET NHT.
C /ZESC/ ESCAPE = .TRUE. INDICATES THAT
                  THE RAY IS ABOVE THE PROFILE
C           IN CURRENT USE. THUS IT HAS
                  ESCAPED AND TRACING STOPS.
C  /ZPRN/ PRINT = .TRUE. INDICATE THE RAY SHOULD BE PRINTED.
C  /ZLEVEL/ CONTROLS INTERPOLATION IN RAYNGE.
C     NLEV= NUMBER OF LEVELS (MUST BE
                  SAME IN EACH PROFILE OF A PATH)
C     LHT(I,J) = HEIGHT OF ITH LEVEL IN JTH PROFILE.
C        THE ATMOSPHER IS ASSUMED TO
                  BE LINEAR ALONG A PATH BETWEEN
C          THE POINTS AT HEIGHT LHT(I,J) AND RANGE (LHT
C          THE POINTS AT HEIGHT LHT(I,
                  J) AND RANGE PRNG(J) AND THE POINT
C        AT HEIGHT LHT(I,J+1) AND RANG(PRNG(J+1)
C  /ZREFL/ CONTROLS REFLECTION FROM ELEVATED LAYER.
C     REFL=.TRUE. WHEN REFLECTION IS
                  TO BE COMPUTED (SET BY *REFLECT CAR
C     LOST=.TRUE. WHEN DUE TO REFLECTIONS
                  SIGNAL HAS BECOME TOO WEAK TO
C          BE FOLLOWEDD.
C     STREN=STRENGTH OF RAY CURRENTLY
                  (AS FRACTION OF ORIGINAL )
C    STPSIG= STRENGTH AT WHICH TO STOP
                  TRACING (I AS A FRACTION OF ORIGI
C     LREFL= LEVEL NUMBER OF LAYER TO
                  BE USED FOR REFLECTION.
C    FREQ=FREQUENCY (IN HERZ) TO BE
                  USED IN CALLELATING ATTENUATION
C
C
C  SUBROUTINES.....
C
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```
C  GETRAY.
C     THIS SUBROUTINE INITIALIZES /CURPOS/
                    FOR THE NEXT RAY TO BE
C     TRACED.  IT RETURNS THE VALUE
                   .TRE. IN ITS ARGUMENT IF THERE
C     IS ANOTHER RAY TO BE DONE AS SPECIFIED
                   ON THE TRACE CARD.
C     OTHERWISE IT RETURNS .FALSE.
C  HTINT(HT,RNG). HEIGHT INTERPOLATION
C     HT= HEIGHT, RNG = RANGE.
C     THIS FUNCTION HAS AS ITS VALUE
                   THE INDEX OF REFRACTION AT THE
C     GIVEN HEIGHT AND RANGE.
C     IT HAS AN ALTERNATE ENTRY POINT
                   HTINTN WHICH IS USED FOR THE FIRST
C     CALL OF A RAY TO INITIALIZE THE
                   'WINDOW' AT T WHICH THE  FUNCTION
C     IS LOOKING. AFTER THAT THE 'WINDOW'
                   MOVES WITH THE RAY.
C  GETCRD. GET CARDS
C     THIS ROUTINE READS CONTROL CARDS
                   WHICH SET VALUES IN COMMONS.
C     IT RETURNS AFTER IT ENCOUNTERS A *TRACE CARD.
C  BUMP.
C     THIS ROUTINE PRFORMS THE ITERATIVE
                   PROCESS OF DETERMINING
C     THE NEXT POSITION OF THE RAY.
C     IT TAKES INTO ACCOUNT TURNING
                   POINTS, REFLECTION FROM THE SURFACE
C     AND REFLECTION FROM A LAYER (UNDER CONTROL OF REFL) .
C     IT CALLS HTINT .
C  DFIND.
C    THIS IS A UTILITY ROUTINE USED
                   TO FIND VALUES IN ARRAYS.
C  PRINT (ENTRY POINTS=STRTRY , OUTPOS)
C     THIS SUBROUTINE PERFORMS THE PRINTING
C     STRTRY IS CALLED WHENEVER AN ARAY
                   IS INITIALIZED. (CALLED BY GETRA
C     OUTPOS IS CALLED (BY MAIN) FOR
                   EVERY POINT COMPUTED.  IT CALLS PLT
C  OUTRAY
C     THIS SUBROUTINE IS CALLED WHENEVER
                   A RAY IS COMPLETED.  ITS MAIN
C     FUNCTION IS TO CONTROL THE TAPES
                   USED IN THGE PLOTTING.
C  OUTALL
C     THIS ROUTINE IS CALLED WHENEVER
                   A GROUP OF ARRAYS HAS BEEN COMPLET
C    IT PERFORMS THE PLOTTING.  IT IS
                   THE ONLY ROUTINE WHICH CALLS THE
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C     PLOTTING ROUTINES.  THUS IF THE
                  PROGRAM IS TO BE REWRITTEN TO
C     PRODUCE PLOTS USING DIFFERENT
                  SUBROUTINES THIS IS THE ONLY
C    SUBROUTINE WHICH WOULD HAVE TO BE CHANGED.
C  PLTPOS.
C     CALL TO CONTROL THE PLOTTING FOR
                  EACH POINT (I.E. IT WRITES INTERM
C     TAPES.
C  ATTEN. FUNCTION WITH TWO ENTRY POINTS
C     ATTEN = COMPUTES THE ATTENUATION
                  COEFFICIENT FOR REFLECTION
C        FROM THE ELEVATIED LAYER AND
                  THE ANGEL AND RANGE SPECIFIED.
C     SURFAT= ATTENUATION DUE TO A REFLECTION
                  FROM THE SURFACE AT THE
C        ANGLE SPECIFIED.
C
C
      CALL PLINIT
C READ CONTROL CARDS, AND PROFILES
  100 CALL GETCRD
C INITIALIZE FOR TRACING A RAY
  110 CALL GETRAY(SUC)
C IF NO MORE RAYS HAVE BEEN SPECIFIED
                  GET MORE CONTORL CARDS.
      IF(.NOT.SUC) GO TO 160
      CALL OUTPOS
  130 CALL BUMP
      CALL FINISH(SUC)
      DO 140 I=1,5
  140 CPOS(I)=NPOS(I)
      CALL OUTPOS
      IF(SUC) GO TO 150
      GO TO 130
C WHEN RAY IS FINISHED TAKE APPROPRIATE ACTIONS.
  150 CALL OUTRAY
      GO TO 110
  160 IF(.NOT.HOLD) CALL OUTALL
      GO TO 100
      END
```

```
$IBFTC XGETCR
      SUBROUTINE GETCRD
      DOUBLE PRECISION PHT,PN,PRNG
      INTEGER CTL(15),TYPE
      INTEGER PEND
      INTEGER DIMP1,DIMP2,DIML1
      INTEGER TYPE1,NAMES(3)
      LOGICAL PRINT
      LOGICAL HOLD
      DOUBLE PRECISION LHT
      REAL PLPAR(6)
      REAL PLTDEF(6)
      INTEGER T1,T2
      LOGICAL PLOT,TEND,FIRSTR
      LOGICAL REFL,LOST
      COMMON /ZREFL/ REFL,LOST,STREN,STPSIG,LREFL,FREQ
      COMMON /ZDIM/ DIMP1,DIMP2,DIML1
      COMMON /ZPLOT/ PLOT,PLFRNG,PLDRNG,
     1          PLHLO,PLHHI,PLDEN,PLHGRD,
     X  THT(40),TRNG(40),T1,T2,TEND,FIRSTR,NRAY
      COMMON /ZLEVEL/ LHT(20,10),NLEV
      COMMON /ZTITLE/ TITLE(13)
      COMMON /ZPRN/PRINT
      COMMON /ZPROF/ PHT(200,10),PN(200,
     1          10),PRNG(10),MAXP(10),NUMP
      COMMON /ZTRCP/ STRTRG,STRTHT,STRTEL,
     1          STPRNG,BMPCT,VBMP,DEL
      COMMON /ZDELHT/DELHT
      COMMON /ZHOLD/ HOLD
      DIMENSION TRCPAR(7)
      DIMENSION PARAM(7)
      DATA (CTL(I),I=1,15) /5H*PATH,
     1          5H*STOP,5H*PROF,6H*PRINT,6H*NOPRI,
     X 6H*TRACE,5H*PLOT,6H*NOPLO,6H*DELHT,6H*REFLE,6H*NOREF,
     X  5H*HOLD,6H*HOLDE,2*0/
      DATA MAXTP /15/
      DATA (NAMES(I),I=1,3) /5HRANGE,6HHEIGHT,2HEL/
      DATA PEND /5H*PEND/
      DATA LEV/6H*LEVEL /
      DATA PLTDEF/0.,100.,0.,4000.,100.,900./
      EQUIVALENCE (PLFRNG,PLPAR(1))
      EQUIVALENCE (STRTRG,TRCPAR(1))
      DOUBLE PRECISION INT,X,Y,X1,X2,Y1,Y2
      INT(X,X1,Y1,X2,Y2) = (X-X1)/(X2-X1)*(Y2-Y1) + Y1
      WRITE(6,911)
C READ CONTROL CARDS AND PROFILES.
  100 CONTINUE
      READ(5,900) TYPE,TYPE1,PARAM
      WRITE(6,906) TYPE,TYPE1
```

```
      DO 110 N=1,MAXTP
  110 IF(CTL(N).EQ.TYPE) GO TO (200,
                  250,300,350,360,400,500,600,370,
     X  650,660,670,680 ) , N
      WRITE(6,901) TYPE,PARAM
      GO TO 100
C *PATH
  200 NUMP=0
      GO TO 100
C *STOP
  250 STOP
C *PROF
  300 NUMP=NUMP+1
      IF(NUMP .GT. DIMP2) GO TO 320
      PRNG(NUMP) = PARAM(1)*1000.
      WRITE(6,907) NUMP,PRNG(NUMP)
      IF(NUMP.GT.1 .AND. PRNG(NUMP).LE.PRNG(NUMP-
                  1))WRITE(6,919)
      IF(NUMP.GT.1 .AND. PRNG(NUMP).LE.PRNG(NUMP-
                  1))GO TO 321
      N=0
C THE GROUND IS ALWAYS A LEVEL
      NL=1
      LHT(1,NUMP)=0.
  310 READ(5,902) TYPE,PHT(N+1,NUMP),PN(N+1,NUMP)
      IF(TYPE.EQ.PEND) GO TO 340
      N=N+1
      PN(N,NUMP) =1.+ PN(N,NUMP)*1.E-6
      IF(N.GE.DIMP1) GO TO 330
      IF(TYPE.EQ.LEV) GO TO 340
       CAPN= (PN(N,NUMP)-1.)*1.E6
       WRITE(6,908) TYPE,PHT(N,NUMP),CAPN
      IF(N.GT.1 .AND. PHT(N,NUMP).LT.PHT(N-
                  1,NUMP) ) GO TO325
      GO TO 310
  320 WRITE(6,903)
  321 NUMP=NUMP-1
      GO TO 335
  325 WRITE(6,920)
      N=N-1
      GO TO 310
  330 WRITE(6,904)
  335 READ(5,902) TYPE
      IF(TYPE .EQ. PEND) GO TO 100
      GO TO 335
C
  340 NL=NL+1
      LHT(NL,NUMP)=PHT(N,NUMP)
      CAPN=(PN(N,NUMP)-1.)*1.E6
```

```
      WRITE(6,914) NL,PHT(N,NUMP),CAPN
      IF(N.GT.1 .AND. PHT(N,NUMP).LT.PHT(N-
     1,NUMP) ) GO TO325
      IF(TYPE.NE.PEND) GO TO 310
C
  345 WRITE(6,908) TYPE
      MAXP(NUMP)=N
C ALL PROFILES MUST HAVE THE SAME NUMBER OF LEVELS
      IF(NUMP.EQ.1) NLEV=NL
      IF(NL.EQ.NLEV) GO TO 100
      NLEV=MIN1(NL,NLEV)
      WRITE(6,917) NLEV
      GO TO 100
C *PRINT
  350 PRINT=.TRUE.
      GO TO 100
C NOPRI
  360 PRINT=.FALSE.
      GO TO 100
C *DELHT
  370 DELHT = PARAM(1)
      WRITE(6,913) DELHT
      GO TO 100
C *TRACE
  400 DO 410 I=1,7
  410 TRCPAR(I)=PARAM(I)
      STRTRG=STRTRG*1000.
      STPRNG=STPRNG*1000.
      READ(5,905) TITLE
      IF(VBMP.EQ.1.) DEL=DEL*1000.
      IF(VBMP.LT.1. .OR. VBMP.GT.3.) BMPCT=1.
      WRITE(6,912) TITLE
      WRITE(6,909) STRTRG,STRTHT,STRTEL,STPRNG
      NBMP=VBMP
      MBMP= BMPCT
      IF(BMPCT .GT. 1.) WRITE(6,910)
     MBMP,NAMES(NBMP),NBMP,DEL
C INITIALIZE PARAMETERS FOR PLOTTING.
      IF(HOLD.AND. NRAY.NE.0) RETURN
      NRAY=0
      T1=2
      T2=3
      TEND = .TRUE.
      REWIND T1
      REWIND T2
      RETURN
C *PLOT
  500 PLOT=.TRUE.
      DO 510 I=1,6
```

```
      PLPAR(I)=PARAM(I)
  510 IF(PARAM(I).EQ.0.) PLPAR(I)=PLTDEF(I)
      PLFRNG=PLFRNG*1.E3
      PLDRNG=PLDRNG*1.E3
      WRITE(6,916) PLPAR
      GO TO 100
C *NOPLO
  600 PLOT=.FALSE.
      GO TO 100
C *REFLE
  650 REFL=.TRUE.
      LREFL=PARAM(1)
      IF(LREFL.EQ.0) LREFL=2
      IF(PARAM(2).LE.0.) PARAM(2)=100.
      STPSIG=-ABS(PARAM(2))
      IF(PARAM(3).EQ.0.) PARAM(3)=50.
      FREQ=PARAM(3)*1.E6
      WRITE(6,918) LREFL,STPSIG,PARAM(3)
      GO TO 100
C *NOREFL
  660 REFL=.FALSE.
      GO TO 100
C *HOLD
  670 HOLD=.TRUE.
      NRAY=0
      GO TO 100
C *HOLDE
  680 CONTINUE
      IF(HOLD) CALL OUTALL
      HOLD=.FALSE.
      GO TO 100
  900 FORMAT(A6,A4,7F10.9)
  901 FORMAT(32H FOLLOWING CARD IS UNRECOGNIZED./
     1X,A6,4X,7F10.4)
  902 FORMAT(A6,4X,3D10.0)
  903 FORMAT(19H TOO MANY PROFILES.)
  904 FORMAT(30H PROFILE HAS TOO MANY HEIGHTS.)
  905 FORMAT(13A6)
  906 FORMAT(5X,A6,A4)
  907 FORMAT(10X,7HPROFILE,I3,3H AT,
     -3PF5.0,3H KM,8X,6HHEIGHT,6X,1HN   )
  908 FORMAT(5X,A6,28X,F7.0,F7.1)
  909 FORMAT(10X,12HSTART RANGE=,-3PF4.0,4H KM./
     2 10X,13HSTART HEIGHT=,0PF5.0,7H METERS /
     3 10X,16HSTART ELEVATION=,0PF7.4,8H RADIANS /
     1 10X,11HSTOP RANGE=,-3PF5.0,3H KM /
     X )
  910 FORMAT(10X5HTRACE,I3,6H RAYS./
     10X8HVARYING A6,10H (VARIABLE
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     X I2,4H) BY,F13.4,11H EACH TIME. )
  911 FORMAT(1H1)
  912 FORMAT(10X,13A6)
  913 FORMAT(10X,6HDELHT=F5.0,8H METERS.)
  914 FORMAT(20X,5HLEVEL,I3,11X,F7.0,F7.1)
  915 FORMAT(40X,F8.0,3PF8.1)
  916 FORMAT(10X,14HPLOTS START AT -3PF5.0,4H KM./
     X  10X,19HEACH FRAME DISPLAYS -3PF5.0,4H KM./
     X  10X,25HMINIMUM HEIGHT DISPLAYED=,0PF6.0,3H M./
     X  10X,25HMAXIMUM HEIGHT DISPLAYED=,0PF6.0,3H M./
     X  10X,23HGRID LINES APPROX EVERY,
                  0PF5.0,14H RASTER UNITS. /
     X  10X,12HPLOT HEIGHT= 0PF5.0,14H RASTER UNITS. )
  917 FORMAT(10X, 40HWRONG NUMBER OF
                  LEVELS, LEVEL  COUNT NOW,I3,1H.)
  918 FORMAT(10X,27HRAY WILL REFLECT FROM LEVEL,I3,1H. /
     X  10X,33HTRACE UNTILL SIGNAL HAS
                  DECREASED 0PF5.0,4H DB./
     X 10X,20HRAY HAS FREQUENCY OF,F6.0,6H MGHZ. )
  919 FORMAT(10X,47HPROFILE RANGES MUST
                  INCREASE.  PROFILE IGNORED.)
  920 FORMAT(40X,46HHEIGHTS MUST INCREASE.
                  PREVIOUS POINT IGNORED. )
      END
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```
$IBFTC XGETRA
      SUBROUTINE GETRAY(NEWRAY)
C INITIALIZE CURPOS FOR THE PLOTTING
                  OF ANOTHER RAY ACCORDING TO THE
C CONTROL INFORMATION INZTRCP
      DOUBLE PRECISION HTINTN
      DOUBLE PRECISION SNELLC
      DOUBLE PRECISION ERAD
      DOUBLE PRECISION CHT,CTHETA,CEL,CN,CRNG
      LOGICAL UP
      LOGICAL NEWRAY
      LOGICAL REFL,LOST
      INTEGER T1,T2
      LOGICAL PLOT,TEND,FIRSTR
      COMMON /ZPLOT/ PLOT,PLFRNG,PLDRNG,
                  PLHLO,PLHHI,PLDEN,PLHGRD,
     X  THT(40),TRNG(40),T1,T2,TEND,FIRSTR,NRAY
      COMMON /ZREFL/ REFL,LOST,STREN,STPSIG,LREFL,FREQ
      COMMON /ZTRCP/ STRTRG,STRTHT,STRTEL,
                  STPRNG,BMPCT,VBMP,DEL
      COMMON /CURPOS/ CHT,CTHETA,CEL,CN,CRNG
      COMMON /ZRAD/ERAD
      COMMON /ZSNELL/ SNELLC
      COMMON /ZUP/ UP
      DIMENSION TRCPAR(7)
      EQUIVALENCE (STRTRG,TRCPAR(1))
      NEWRAY = .FALSE.
      IF(BMPCT.LT. .1 ) RETURN
C THERE WAS ANOTHER RAY SPECIFIED.
      NEWRAY=.TRUE.
      CRNG=STRTRG
      CHT=STRTHT
      CEL =STRTEL
      CTHETA=CRNG/ERAD
      STREN=0.
      UP = CEL .GE. 0.
      CN= HTINT (CHT,CRNG)
      SNELLC =CN*(1.+CHT/ERAD)*DCOS(CEL)
      NRAY=NRAY+1
      IF(NRAY.GT.40) WRITE(6,900)
      IF(NRAY.GT. 40) NRAY=40
      CALLSTRTRY
      BMPCT=BMPCT-1.
      N=VBMP+.1
      IF(N.EQ.0)RETURN
      TRCPAR(N)=TRCPAR(N)+DEL
      RETURN
  900 FORMAT(58HOATTEMPT TO PLOT MORE
                  THAN 40 RAYS TOGETHER. ONLY 40 USE
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XD.)
 END
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$IBFTC XBUMP
      SUBROUTINE BUMP
      DOUBLE PRECISION SNELLC
      DOUBLE PRECISION ERAD
      DOUBLE PRECISION NHT,NTHETA,NEL,NN,NRNG
      DOUBLE PRECISION CHT,CTHETA,CEL,CN,CRNG
      DOUBLE PRECISION HTINT,HTINTN
      DOUBLE PRECISION CTAN,NTAN,XSQ,XD1,HALFPI
      DOUBLE PRECISION     DARCOS
      DOUBLE PRECISION COSEL,CRN,RNN
      DOUBLE PRECISION HLIN1,HLIN2
      DOUBLE PRECISION RBAR,HBAR,DENOM,DTHETA
      DOUBLE PRECISION PHT,PN,PRNG
      DOUBLE PRECISION LHT
      DOUBLE PRECISION A,B,C,D,RT1,RT2
      LOGICAL UP
      LOGICAL ESCAPE
      LOGICAL TURN
      LOGICAL REFL,LOST
      COMMON /ZREFL/ REFL,LOST,STREN,STPSIG,LREFL,FREQ
      COMMON /ZINTL/ HLIN1,HLIN2
      COMMON /NXTPOS/ NHT,NTHETA,NEL,NN,NRNG
      COMMON /CURPOS/ CHT,CTHETA,CEL,CN,CRNG
      COMMON /ZESC/ ESCAPE
      COMMON /ZUP/ UP
      COMMON /ZRAD/ERAD
      COMMON /ZSNELL/ SNELLC
      COMMON /ZDELHT/ DELHT
      COMMON /ZIX/ IXP1,IXP2,IXH1,IXH2,IXL,IXP,IXH
      COMMON /ZPROF/ PHT(200,10),PN(200,
     1      10),PRNG(10),MAXP(10),NUMP
      COMMON /ZLEVEL/ LHT(20,10),NLEV
C     THIS SETS UP THE NEXT POINT FOR STEP.
C     IT INCREMENTS HIGHT, AND ELEVATION.
      LOST=.FALSE.
      TURN=.FALSE.
  100 CONTINUE
C HTLIN1, AND HLIN2 ARE THE BOUNDS IN
C                 WHICH THE ATMOSPHERIC MODEL IS
C LINEAR AROUND THE LAST HEIGHT FOR WHICH HTINT WAS CALLED.
C TO INSURE PROPER TRACING, ESPECIALLY
C                 NEAR LAYERS THESE HEIGHTS SHOULD
C BE EXPLICITY USED.
      IF(UP) NHT=DMIN1(CHT+DELHT,HLIN2)
      IF(UP) NHT=DMAX1(CHT+1.,NHT)
      IF(.NOT.UP) NHT=DMAX1(CHT-DELHT,HLIN1)
      IF(.NOT.UP) NHT=DMIN1(CHT-1.,NHT)
C     SPECIAL ACTION IF WE GO BELOW O HEIGHT.
      IF(NHT .GE. 0.) GO TO 150
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C HAVE'NT QUITE REACHED THE SURFACE. GO TO IT THIS TIME.
      IF(CHT .GT. 0.)GO TO 140
C START BACK UP.
C MAY WANT A NEW PROFILE FIRST.
      UP=.TRUE.
      CEL=ABS(CEL)
      IF(REFL) STREN=STREN+ALOG10(SURFAT(CEL))
      IF(REFL) LOST=STREN.LT.STPSIG
      GO TO 100
  140 NHT=0.
  150 CONTINUE
C NOTE. IXL IS THE VALUE SET BY THE
                  LAST CALL TO HTINT WHICH SHOULD HAVE
C BEEN THE CALL DURING BUMP FOR CHT
      IF(.NOT.REFL .OR. .NOT.UP .OR. IXL.NE.LREFL) GO TO 160
C WANT THE REFLECT FROM A LAYER
      CEL=-CEL
C CORRECT FOR LANT OF LAYER
      IF(IXP1.NE.IXP2) CEL=CEL+
     X  2.*DATAN( DBLE( (LHT(LREFL,IXP2)-LHT(LREFL,IXP1)) /
     X  (PRNG(IXP2)-PRNG(IXP1)) ))
      UP=CEL.GE.0.
C RECOMPUTE SNELLS CONSTANT
      SNELLC=CN*(1.+CHT/ERAD)*DCOS(CEL)
      STREN=STREN+ALOG10(ATTEN(CEL,CRNG))
      LOST=STREN.LT.STPSIG
CH
      CHT= (LHT(LREFL,IXP2)-LHT(LREFL,
                  IXP1)) * (CRNG-PRNG(IXP1)) /
     * (PRNG(IXP2) -PRNG(IXP1)) + LHT(LREFL,IXP1)
      CN=
      CN=HTINT(CHT,CRNG)
      GO TO 100
  160 CONTINUE
      NN=HTINT(NHT,CRNG)
      COSEL = SNELLC/(NN*(1.+NHT/ERAD))
C CHECK IF WE HAVE REFLECTION
      IF(COSEL .GT. 1.)GO TO 200
      NEL =DARCOS(COSEL)
      IF(.NOT.UP) NEL=-NEL
      GO TO 210
C
C HERE WHEN WE HAVE A TURNING POINT.
200   CONTINUE
      IF(CEL.NE.0.) GO TO 202
      NHT=(CHT+NHT)/2.
      IF(ABS(NHT-CHT).GT..4) GO TO 160
      NHT=CHT
      NEL=CEL
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      IF(TURN) GO TO 205
      TURN=.TRUE.
      UP=.NOT.UP
      GO TO 100
202   CONTINUE
C     NEW HEIGHT SOLUTION OF FOLLOWING QUADRATIC EQUATION
C     SNELLC*ERAD=(CN+DNDH*(NHT-CHT))*(ERAD+NHT)
C     WHERE DNDH IS LOCAL DERIVITIVE OF N
      DNDH=(NN-CN)/(NHT-CHT)
      A=DNDH
      B=DNDH*(ERAD-CHT)+CN
      C=ERAD*(CN-DNDH*CHT-SNELLC)
      D=SQRT(B*B-4.*A*C)
      RT1=.5*(-B+D)/A
      RT2=.5*(-B-D)/A
      T1=(CHT-RT1)*(NHT-RT1)
      T2=(CHT-RT2)*(NHT-RT2)
      NHT=RT2
      IF(T1.LE.0.0.AND.(T2.GT.0.0.OR.T2.LE.0.0.AND.ABS(T1-
                  CHT).LE.
     1ABS(T2-CHT))) NHT=RT1
      IF(T1.GE.0.0.AND.T2.GE.0.0.AND.T1.LT.T2) NHT=RT1
      IF(T1.GT.0.0.AND.T2.GT.0.0) GO TO 205
      NEL=0.
      NN=SNELLC/(1.+NHT/ERAD)
      UP=.NOT.UP
      IF(TURN.AND. ABS(NHT-CHT).LT..001) GO TO 205
      TURN=.TRUE.
      IF(ABS(NHT-CHT).LT..001) GO TO 100
      GO TO 210
C WAVE IS JUST FOLLOWING CURVOTURE
205   DTHETA=.0015
      GO TO 250
C NOW WE COMPLETE THE NEW POSITION OF
                  THE RAY BY DETERMINING THETA AND
C RANGE.  THIS ROUTINE USES FORMULA'S
                  DERIVED BY GARDINER. SEE
C PACIFIC MISSLE RANGE TECHNICAL NOTE 3280-6.
C DETERMINATION OF ELEVATION AND SLANT
                  RANGE ERRORS DUE TO ATMOSPHERIC
C REFRACTION.
  210 CONTINUE
      RBAR=.5*(CN+NN)
      HBAR = (CHT+NHT)/2.
      DENOM = (NN-CN)*(HBAR+ERAD) + RBAR*(NHT-CHT)
      IF(DABS(DENOM).LT. .01) GO TO 300
      DTHETA = (NEL-CEL)*RBAR*(NHT-CHT)/DENOM
      IF(DTHETA .LT. 0.DO .OR. DTHETA .GT. .01DO) GO TO 300
  250 CONTINUE
```

```
      NTHETA=CTHETA + DTHETA
      NRNG = NTHETA*ERAD
      RETURN
C DENOMINATOR IS TOO SMALL.
C THIS SHOULDN'T HAPPEN OFTEN.  WHEN
C                 IT DOES USE ALTERNATE FORM
C OF EQUATIONS.
  300 CONTINUE
      CTAN = DSIN(CEL)/DCOS(CEL)
      NTAN= DSIN(NEL)/DCOS(NEL)
      XSQ= ( (NTAN-CTAN)/(1.+NTAN*CTAN) )**2
      XD1= (NN*(NHT-CHT)*(1./DCOS(CEL)+1./DCOS(NEL)))/
     X  (SNELLC*(NTAN+CTAN)*(1.+NTAN*CTAN)*ERAD)
      DTHETA=XD1*(1.+XSQ/3.-XSQ*XSQ/5.+XSQ*XSQ*XSQ/7.)
      GO TO 250
      END
```

```
$IBFTC XHTINT
      DOUBLE PRECISION FUNCTION HTINT(HT,RANGE)
C RETURNS THE INDEX OF REFRACTION AT
C                THE GIVEN HEIGHT AND RANGE.
      DOUBLE PRECISION HT,RANGE
      DOUBLE PRECISION INT,X,X1,X2,Y1,Y2
      DOUBLE PRECISION LINT,REL,HT1,HT2
      DOUBLE PRECISION LINTHI,LINTLO
      DOUBLE PRECISION LHT
      DOUBLE PRECISION PHT,PN,PRNG
      DOUBLE PRECISION HLIN1,HLIN2
      LOGICAL LAYER
      DOUBLE PRECISION HTREL
      LOGICAL ESCAPE
      LOGICAL ESC
      COMMON /ZINTL/ HLIN1,HLIN2
      COMMON /ZESC/ ESCAPE
      COMMON /ZPROF/ PHT(200,10),PN(200,
     1      10),PRNG(10),MAXP(10),NUMP
      COMMON /ZLEVEL/ LHT(20,10),NLEV
      COMMON /ZIX/ IXP1,IXP2,IXH1,IXH2,IXL,IXP,IXH
C
      INT(X,X1,Y1,X2,Y2) = (X-X1)/(X2-X1)*(Y2-Y1) + Y1
C
C     HTINTN IS CALLED AT THE BEGINNING OF A RAY.
      ENTRY HTINTN(HT,RANGE)
  100 CONTINUE
C
C TEST IF THERE IS TO BE INTERPOLATION IN HEIGHT ONLY
      IXP=1
      IF(NUMP.EQ.1) GO TO 310
C
C FIND THE PROFILES FOR RANGE INTERPLATION.
      CALL DFIND( RANGE,PRNG,NUMP,IXP1,ESC)
      IXP2=IXP1+1
C IF PAST LAST PROFILE USE IT ONLY
      IF(ESC) GO TO 300
C IF THERE ARE LEVELS FIND OUT WHICH ONE THIS IS IN.
      IF(NLEV.EQ.1) GO TO 210
      NL=NLEV-1
      DO 200 IXL=1,NL
      LINTHI=INT( RANGE, PRNG(IXP1), LHT(IXL+1,IXP1),
     X     PRNG(IXP2),LHT(IXL+1,IXP2) )
  200 IF(LINTHI.GE.HT) GO TO 220
  210 HT1=HT
      HT2=HT
      GO TO 230
  220 LINTLO=INT(RANGE,PRNG(IXP1),LHT(IXL,IXP1),PRNG(IXP2),
     X     LHT(IXL,IXP2) )
```

```
      REL= (HT-LINTLO)/(LINTHI-LINTLO)
      HT1=LHT(IXL,IXP1) + REL*(LHT(IXL+
                  1,IXP1) -LHT(IXL,IXP1))
      HT2=LHT(IXL,IXP2) + REL*(LHT(IXL+
                  1,IXP2) -LHT(IXL,IXP2))
  230 CALL DFIND(HT1,PHT(1,IXP1),MAXP(IXP1),IXH1,ESC)
      ESCAPE=ESC
      CALL DFIND(HT2,PHT(1,IXP2),MAXP(IXP2),IXH2,ESC)
      ESCAPE=ESC.OR.ESCAPE
      RN1=INT(HT1, PHT(IXH1,IXP1),PN(IXH1,IXP1),
     X  PHT(IXH1+1,IXP1),PN(IXH1+1,IXP1) )
      RN2=INT(HT2, PHT(IXH2,IXP2),PN(IXH2,IXP2),
     X  PHT(IXH2+1,IXP2),PN(IXH2+1,IXP2) )
      HTINT=INT(RANGE,PRNG(IXP1),RN1,PRNG(IXP2),RN2 )
      HLIN1=DMAX1(
     X  INT(PHT(IXH1,IXP1),LHT(IXL,IXP1),
                  LINTLO,LHT(IXL+1,IXP1),LINTHI),
     X  INT(PHT(IXH2,IXP2),LHT(IXL,IXP2),
                  LINTLO,LHT(IXL+1,IXP2),LINTHI))
      HLIN2=DMIN1(
     XINT(PHT(IXH1+1,IXP1),LHT(IXL,IXP1),
                  LINTLO,LHT(IXL+1,IXP1),LINTHI),
     XINT(PHT(IXH2+1,IXP2),LHT(IXL,IXP2),
                  LINTLO,LHT(IXL+1,IXP2),LINTHI))
      RETURN
C COME HERE WHEN THERE IS ONLY ONE PROFILE TO BE USED
  300 CONTINUE
      IXP=IXP2
      IF(RANGE.LE.PRNG(1)) IXP=1
C INTERPOLATE THE INDEX IN THAT PROFILE
  310 CALL DFIND(HT,PHT(1,IXP),MAXP(IXP ),IXH,ESCAPE)
      HTINT=INT(HT,PHT(IXH,IXP),PN(IXH,IXP),
     X  PHT(IXH+1,IXP),PN(IXH+1,IXP))
      HLIN1=PHT(IXH,IXP)
      HLIN2=PHT(IXH+1,IXP)
C FOR USE IN CASE OTHER ROUTINES WANT TO LOCATE RAY
      IXP1=IXP
      IXP2=IXP
      IXH1=IXH
      IXH2=IXH
      CALL DFIND(HT,LHT(1,IXP),NLEV,IXL,ESC)
      RETURN
      END
```

```
$IBFTC XDFIND
      SUBR0UTINE DFIND(X,DATA,LIM,L1,   ESC)
      D0UBLE PRECISI0N DATA(1),X
      L0GICAL ESC
C
C THIS SUBR0UTINE L0CATES THE ENTRYS
                  IN A TABLE 0F ASCENDING VALUES
C WHICH BRACKET X.
C DATA IS THE TABLE. IT MUST BE ARRANGED IN ASCENDING 0RDER.
C     I.E. DATA(I) .LE. DATA(I+1)
C LIM IS THE NUMBER 0F ENTRIES IN THE TABLE.
C L1 0N RETURN IS THE L0WER SIDE 0F THE BRACKET. I.E.
C     DATA(L1) .LE. X .LE. DATA(L1+1)
C IF X FALLS 0UTSIDE THE TABLE ESC IS
                  SET TRUE, AND L1 IS SET T0 1
C 0R LIM-1 DEPENDING 0N WHETHER X IS
                  BEL0W 0R AB0VE THE RANGE C0VERED
C BY THE TABLE.
C
C IF L1 0N ENTRY IS WITHIN THE LIMITS
                  0F THE TABLE, THE SEARCH F0R
C L1 WILL START FR0M ITS CURRENT VALUSE.
                   (THIS WILL MAKE REPEATED
C CALLS M0RE EFFICIENT IN MANY CASES).
C
C
      ESC=.FALSE.
      IF(L1.GT.0.AND.L1.LT.LIM) G0 T0 110
      L1=1
  110 C0NTINUE
      IF(DATA(L1).GT.X)G0 T0 150
      IF(DATA(L1+1) .GT. X) RETURN
      L1=L1+1
      IF(L1.LT.LIM)G0 T0 110
      L1=LIM-1
      G0 T0 200
  150 IF(L1.LE.1)G0 T0 200
      L1=L1-1
      G0 T0 110
  200 C0NTINUE
  210 ESC=.TRUE.
      RETURN
      END
```

```
$IBFTC XATTEN
      REAL FUNCTION ATTEN(EL,RNG)
C COMPUTE THE REFLECTION COEFFICIENT
                  FOR THE SPECIFIED LAYER AT THE
C GIVEN RANGE FOR A RAY WITH THE GIVEN ELEVATION.
      DOUBLE PRECISION EL,RNG
      DOUBLE PRECISION PHT,PN,PRNG
      DOUBLE PRECISION LHT
      LOGICAL REFL,LOST
      COMMON /ZREFL/ REFL,LOST,STREN,STPSIG,LREFL,FREQ
      COMMON /ZIX/ IXP1,IXP2,IXH1,IXH2,IXL,IXP,IXH
      COMMON /ZPROF/ PHT(200,10),PN(200,
                  10),PRNG(10),MAXP(10),NUMP
      COMMON /ZLEVEL/ LHT(20,10),NLEV
      DATA PI/3.141592/
C TEST IF THERE IS ONLY ONE KPROFILE.
      X=0.
      IF(IXP1.EQ.IXP2) GO TO 110
      X= (RNG-PRNG(IXP1))/(PRNG(IXP2)-PRNG(IXP1))
  110 CONTINUE
      HT=(1.-X)*LHT(LREFL,IXP1) + X*LHT(LREFL,IXP2)
      SLOPE= (HTINT(HT+10.,RNG)-HTINT(HT ,RNG)) *1.E-7
      VATTEN=SLOPE*(3.E8/FREQ)/(8.*PI*SIN(EL)**3)
      ATTEN=AMIN1(VATTEN**2,1.)
      RETURN
      ENTRY SURFAT(EL)
C COMPUTE REFLECTION COEFFICIENT FROM SURFACE.
C USE FORMULAS FROM ESSA TECH. REPT.
                  ERL 79-ITS 67, PAGE B-4.
C ASSUME WAVE HEIGHT OF 3 METERS.
      DATA WHT/3./
      DATA PI/3.14159/
      VATTEN= AMAX1(EXP(-2.*PI*.39*WHT*SIN(EL)/(3.E8/FREQ)),
     X SQRT(ABS(SIN(EL))) )
      ATTEN=VATTEN**2
      RETURN
      END
```

```
$IBFTC XPRINT
      SUBROUTINE STRTRY
      DOUBLE PRECISION CHT,CTHETA,CEL,CN,CRNG
      LOGICAL PRINT
      LOGICAL REFL,LOST
C
      COMMON /ZREFL/ REFL,LOST,STREN,STPSIG,LREFL,FREQ
      COMMON /ZPRN/PRINT
      COMMON /ZTITLE/ TITLE(13)
      COMMON /CURPOS/ CHT,CTHETA,CEL,CN,CRNG
C
      IF(.NOT.PRINT) GO TO 300
      WRITE(6,904)
      WRITE(6,905) TITLE
      WRITE(6,900)
      WRITE(6,902)
      WRITE(6,903)
      NCT=0
      RETURN
      ENTRY OUTPOS
      CALL PLTPOS
      IF(.NOT.PRINT) RETURN
  200 CORN=(CN-1.)*1.E6
      WRITE(6,901)  CRNG,CHT,CEL,CORN,CTHETA
      NCT=NCT+1
      IF(NCT.LT.50) RETURN
      NCT=0
      WRITE(6,904)
      WRITE(6,900)
      WRITE(6,902)
      WRITE(6,903)
      RETURN
  300 WRITE(6,906) CHT,CRNG,CEL
      RETURN
      ENTRY OUTRAY
      WRITE(6,907) CHT,CRNG,CEL,STREN
      CALL PLTRAY
      RETURN
  900 FORMAT(10X,5HRANGE,9X,6HHEIGHT,
                 6X,9HELEVATION,11X,4HREF.,10X,
     X 5HTHETA)
  901 FORMAT(-3PF15.4,0PF15.1,F15.4,F15.1,E15.3)
  902 FORMAT(10X,5(2HIN,13X)/12X3HKM.,
                 9X6HMETERS,8X7HRADIANS,8X7HN UNITS
     X 8X7HRADIANS)
  903 FORMAT(1HO)
  904 FORMAT(1H1)
  905 FORMAT(20X,8HNEW RAY,5X,13A6/1X)
  906 FORMAT(1HO,9X,13HSTART HEIGHT=F6.0,
                  3H M.,5X12HSTART RANGE=,
```

```
     X -3PF5.0,4H KM.,5X9HSTART EL=0PF8.4,5H RAD. )
  907 FORMAT(11X,12HSTOP HEIGHT=F6.0,
                 3H M.,6X11HSTOP RANGE=-3PF5.0,
     X 4H KM.,6X8HSTOP EL=0PF8.4,5H
                 RAD.,6X,12HATTENUATION=F6.0,4H DB.)
       END
```

```
$IBFTC XFIN
      SUBROUTINE FINISH(DONE)
      DOUBLE PRECISION CHT,CTHETA,CEL,CN,CRNG
      DOUBLE PRECISION NHT,NTHETA,NEL,NN,NRNG
      LOGICAL ESCAPE
      LOGICAL DONE
      LOGICAL REFL,LOST
      COMMON /ZREFL/ REFL,LOST,STREN,STPSIG,LREFL1,LREFL2
      COMMON /CURPOS/ CHT,CTHETA,CEL,CN,CRNG
      COMMON /NXTPOS/ NHT,NTHETA,NEL,NN,NRNG
      COMMON /ZTRCP/ STRTRG,STRTHT,STRTEL,
     1          STPRNG,BMPCT,VBMP,DEL
      COMMON /ZESC/ ESCAPE
      DONE= NRNG.GE.STPRNG .OR. ESCAPE .OR. LOST
      IF(NRNG.LE.STPRNG) RETURN
      X=(STPRNG-CRNG)/(NRNG-CRNG)
      NRNG=STPRNG
      NHT=CHT+ X*(NHT-CHT)
      NTHETA=CTHETA+ X*(NTHETA-CTHETA)
      NEL=CEL+X*(NEL-CEL)
      NN=CN+ X*(NN-CN)
      RETURN
      END
```

```
$IBFTC TRCBLK
      BLOCK DATA
      DOUBLE PRECISION ERAD
      INTEGER DIMP1,DIMP2,DIML1
      LOGICAL HOLD
      COMMON /ZHOLD/ HOLD
      COMMON /ZDIM/ DIMP1,DIMP2,DIML1
      COMMON /ZRAD/ERAD
      COMMON /ZHTLAY/ HTLAY
      COMMON /ZDELHT/ DELHT
      DATA ERAD/ 6371.2D3/
      DATA DIMP1,DIMP2 /200,10/
      DATA DIML1 /20/
      DATA HOLD/.FALSE./
      DATA DELHT /20./
      END
```

```
$IBFTC XPLTRA
      SUBROUTINE PLTRAY
      INTEGER T1,T2
      LOGICAL PLOT,TEND,FIRSTR
      LOGICAL PRINT
      COMMON /ZPRN/PRINT
      COMMON /ZPLOT/ PLOT,PLFRNG,PLDRNG,
                     PLHLO,PLHHI,PLDEN,PLHGRD,
     X  THT(40),TRNG(40),T1,T2,TEND,FIRSTR,NRAY
C THIS ROUTINE FINDS THE END OF TAPE T1 AND MARKS IT. ON T2.
      IF(.NOT.PLOT) RETURN
C IF ALREADY AT END GO MARK T2
      IF(TEND) GO TO 120
  110 READ(T1) THT,TRNG
      IF(THT(1).LT.-5.) GO TO 120
      THT(NRAY)=-1.
      WRITE(T2) THT,TRNG
      GO TO 110
C AT END OF TAPE MARK IT.
  120 CONTINUE
      DO 125 N=1,NRAY
  125 THT(N)=-1.
      THT(1)=-10.
      WRITE(T2) THT,TRNG
      ENDFILE T2
      REWIND T1
      REWIND T2
C SWITCH ROLES TO T1 AND T2.
      I=T1
      T1=T2
      T2=I
C NO LONGER ON FIRST RAY OR AT END OF TAPE
      TEND=.FALSE.
      RETURN
  900 FORMAT(1HO,9X,12HATTENUATION=F5.0,4H DB.)
      END
```

```
$IBFTC XOUTAL
      SUBROUTINE OUTALL
      LOGICAL MORE
      LOGICAL OVER
      LOGICAL HOLD
      REAL THTX(40),TRNGX(40)
      INTEGER TIN
      INTEGER T1,T2
      LOGICAL PLOT,TEND,FIRSTR
      LOGICAL PRINT
      COMMON /ZPRN/ PRINT
      COMMON /ZHOLD/ HOLD
      COMMON /ZTITLE/ TITLE(13)
      COMMON /ZPLOT/ PLOT,PLFRNG,PLDRNG,
     1            PLHLO,PLHHI,PLDEN,PLHGRD,
     X  THT(40),TRNG(40),T1,T2,TEND,FIRSTR,NRAY
C THIS ROUTINE USES THE TAPE PRODUCED
     1            BY OUTPOS AND OUTRAY TO PLOT
C THE RAY PATHS.
      IF(.NOT.PLOT) RETURN
      MORE=.TRUE.
      TIN=T1
      FRMRNG=PLFRNG
  190 TORNG=FRMRNG + PLDRNG
      IF(.NOT.MORE) RETURN
      MORE=.FALSE.
      REWIND TIN
      CALL SETMIV(50,0,50,1023-50-IFIX(PLHGRD))
      CALL DXDYV(1,FRMRNG/1000.,TORNG/
     1            1000.,DX,N,I,NX,PLDEN,IERR)
      CALL DXDYV(2,PLHLO,PLHHI,DY,M,J,NY,PLDEN,IERR)
      CALL GRID1V(3,FRMRNG/1000.,TORNG/1000.,PLHLO,PLHHI,
     X  DX,DY,N,M,I,J,NX,NY)
      CALL RITE2V(300,20,1000 ,90,1,30, -1,TITLE,IERR)
C READ IN THE RIST POINTS
  220 READ(TIN) THT,TRNG
C READ IN THE NEXT SET OF POINTS
  230 READ(TIN) THTX,TRNGX
      WRITE(6,1) (THTX(I),TRNGX(I), I=1,NRAY)
1     FORMAT(10F10.0)
C IF AT END OF TAPE, WE ARE DONED.
      IF(THTX(1) .GT. -5.) GO TO 240
      FRMRNG=TORNG
      IF(MORE) GO TO 190
      RETURN
  240 OVER=.TRUE.
      DO 300 N=1,NRAY
      MORE=MORE .OR. (TRNGX(N).GT.TORNG .AND. THTX(N).GE.0.)
      IF( TRNGX(N).LE.TORNG .AND. THTX(N).GE.0.)
     1            OVER=.FALSE.
```

```
      IF(THT(N).LT.0. .OR. TRNGX(N).LT.FRMRNG
     .                .OR. TRNG(N).GT.TORNG)
     X   GO TO 290
      IF(TRNG(N).EQ.TORNG .OR. TRNGX(N).EQ.FRMRNG) GO TO 290
      IF(THTX(N).GT.PLHHI) GO TO 290
      IF(TRNG(N).GE.FRMRNG.AND.TRNGX(N).LE.TORNG) GO TO 270
      IF(TRNG(N) .LT. FRMRNG) GO TO 260
C AT END OF FRAME.
      THTX(N)=THT (N)+ (TORNG-TRNG(N))/(TRNGX(N)-TRNG(N)) *
     X  (THTX(N)-THT(N))
      TRNGX(N)=TORNG
      GO TO 270
C AT START OF FRAME.
  260 THT(N)=THT(N) + (FRMRNG-TRNG(N))/(TRNGX(N)-TRNG(N))*
     X  (THTX(N)-THT(N))
      TRNG(N)=FRMRNG
  270 CONTINUE
C HAVE A RAY SEGMENT TO PLOT,  ALSO
                  INDICATE THAT THE MAY STILL BE
C MORE POINTS TO PLOT.
      NH=NYV(THT(N))
      NR= NXV(TRNG(N)/1000.)
      NHX=NYV(THTX(N))
      NRX=NXV(TRNGX(N)/1000.)
      IF(NH.NE.0 .AND. NR.NE.0 .AND.
                  NHX.NE.0 .AND. NRX.NE.0)
     X   CALL LINEV(NR,NH,NRX,NHX)
  290 TRNG(N)=TRNGX(N)
      THT(N)=THTX(N)
  300 CONTINUE
      IF(.NOT.OVER) GO TO 230
C HAVE FINISHED A FRAME.
      FRMRNG=TORNG
      GO TO 190
      ENTRY PLINIT
C
C GARBAGE FOR PLOTTING STARTUP
      EXTERNAL TABL1V
      CALL RITSTV(24,17,TABL1V)
      CALL RITE2V (100,500,1000,90,1,7,-1,7HWILSON ,N)
C
      HOLD=.FALSE.
      PRINT=.FALSE.
      PLOT=.FALSE.
      RETURN
      END
```

```
$IBFTC XPLTP0
      SUBR0UTINE PLTP0S
      D0UBLE PRECISI0N CHT,CTHETA,CEL,CN,CRNG
      L0GICAL PL0T,TEND,FIRSTR
      INTEGER T1,T2
      C0MM0N /CURP0S/ CHT,CTHETA,CEL,CN,CRNG
      C0MM0N /ZPL0T/ PL0T,PLFRNG,PLDRNG,
                     PLHL0,PLHHI,PLDEN,PLHGRD,
     X  THT(40),TRNG(40),T1,T2,TEND,FIRSTR,NRAY
C THIS SUBR0UTINE 0UTPUTS A TAPE WHICH
                     WILL LATTER BE USED T0
C PR0DUCE A PL0T.
C EACH L0GICAL REC0RD C0NTAINS THE HEIGHT
                     AND RANGE 0F UP T040 RAYS.
C A NEGATIVE HEIGHT INDICATES THAT THERE
                     IS D N0 DATA PRESENT F0R THAT
C RAY IN THIS REC0RD.  A VALUE .LT.
                     -5. F0R THE FIRST HEIGHT INDICATES
C THAT THIS IS THE END 0F THE TAPE. (I.E. A L0GICAL E0F).
C
      IF(.N0T.PL0T) RETURN
C EXCEPT FIRST RAY, 0R WHEN END 0F TAPE
                     IS REACHED READ IN  AN 0LD
C REC0RD.
      IF           (   TEND) G0 T0 200
      READ(T1) THT,TRNG
C TEST F0R END 0F TAPE.
      IF(THT(1) .GE. -5.) G0 T0 200
      TEND =.TRUE.
      THT(1)=-1.
C WILL USE THT(1) IN WRITTING S0 D0N'T LET IT BE -10.
  200 THT(NRAY) = CHT
      TRNG(NRAY)=CRNG
      WRITE(T2) THT,TRNG
      RETURN
      END
```

```
/
      TRACE--DARC0S, D0UBLE PRECISI0N ARC C0SINE     PAGE    1

$IBFTC XARC0S
     /D0UBLE PRECISI0N FUNCTI0N DARC0S(X)
      D0UBLE PRECISI0N X
      D0UBLE PRECISI0N PI
      DATA PI /3.14159265358979300/
      DARC0S= DATAN(DSQRT(1.D0-X*X)/X)
      IF(X.LT.0.D0) DARC0S=PI+DARC0S
      RETURN
```

CONTROL CARD SUMMARY

FUNCTION		PARAMETERS						
COL. 1-10		COL. 11-20	COL. 21-30	COL. 31-40	COL. 41-50	COL. 51-60	COL. 61-70	COL. 71-80
* PRINT	TURNS ON PRINTING OPTION							
* NO PRINT	TURNS OFF PRINTING OPTION							
* STOP	TERMINATES PROCESSING							
* PATH	RESETS PROGRAM FOR NEW PROFILE							
* PROF	INITIATES READING OF PROFILE	RANGE						
* PEND	TERMINATES READING OF PROFILE							
* TRACE	INITIATES RAY TRACING	START-RANGE	START-HEIGHT	START-ELEVATION	STOP-RANGE	BUMP-COUNT	BUMP-VARIABLE	DEL
* PLOT	TURNS ON PLOTTING OPTION	START-RANGE	FRAME-RANGE	FRAME-BOTTOM	FRAME-TOP	DENSITY	GRID	
* NO PLOT	TURNS OFF PLOTTING OPTION							
* DELHT	CONTROLS STEP SIZE	DEL						
* REFLECT	TURNS ON REFLECTION OPTION	LEVEL	STOP-ATTENUATION	FREQ				
* NO REFLECT	TURNS OFF REFLECTION OPTION							
* HOLD	DELIMITS START OF RAY COLLECTION							
* HOLD END	DELIMITS END OF RAY COLLECTION							
	PROFILE DESCRIPTION	HEIGHT	N					
* LEVEL	PROFILE DE-SCRIPTION (LEVEL)	HEIGHT	N					
	TITLE (alphanumeric title in Col. 1 - 30)							

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Syracuse University Research Corporation Merrill Lane, University Heights, Syracuse, New York 13210	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP N/A

3. REPORT TITLE

DESCRIPTION OF COMPUTER PROGRAMS FOR THE ANALYSIS AND PRESENTATION OF TRADE WINDS DATA

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

None

5. AUTHOR(S) *(First name, middle initial, last name)*

Jerald Schwarz

6. REPORT DATE December 1969	7a. TOTAL NO. OF PAGES 147	7b. NO. OF REFS 0
8a. CONTRACT OR GRANT NO. F19628-68-C-0209 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) ESD-TR-70-32 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*	

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Aerospace Instrumentation Program Office, Electronic Systems Division, AFSC, USAF, L G Hanscom Field, Bedford, Mass. 01730

13. ABSTRACT

An investigation of the Trade Wind Duct was carried out from March 6 through March 25, 1969 in the Northern part of the Caribbean Sea. An instrumented aircraft was used to record meteorological and radio refractivity data in digitized format for computer analysis. In addition, extensive radiosonde data was included in the analysis to support the aircraft measurements and provide a basis for weather analysis. In order to assimilate, process and present such a large amount of data it was imperative that machine processing be used. The following report describes the various programs which were used in the analysis and presentation of the data. A ray-tracing program was also developed to analyze radio wave propagation in relation to Trade Wind Duct characteristics. This program has the advantage that horizontal changes in the Duct can be included. Most ray-tracing programs assume that the vertical variation of refractivity is spherically stratified.

DD FORM 1 NOV 65 1473

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
1. Ray Tracing Program 2. Radio-Meteorology 3. Meteorological Data Analysis 4. TradeWinds Data Analysis Program 5. Computer Analysis of Radio-Meteorological Data.						